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STUDY OF CURRENT AND PROPOSED PRACTICES IN ANIMAL WASTE MANAGEMENT

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Abstracts were prepared of 1162 publications dealing with animal waste utilization and/or disposal, or closely related materials having direct carry-over potential. These latter publications pertained to some other aspect of manure management or to thermochemical processing of some other organic material. In addition, abstracts of 111 pertinent projects sponsored by the USDA were included in a separate appendix. Land spreading, with or without advantage being taken of the fertilizer and soil-conditioning values, is the ultimate destiny of nearly all manure produced at present. Attention was focused in the report, however, on the less-used but potentially more rewarding processes of gas or oil recovery, refeeding to animals after more or less processing, and using as a culture medium for fly larvae, worms, algae, fungi, yeast, etc., with ultimate disposal of the catabolized manure as a soil conditioner, and utilization of the organisms as feedstuffs.

This report was submitted in fulfillment of Contract No. 68-01-0785 under the sponsorship of the Office of Research and Monitoring, Environmental Protection Agency.

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STUDY OF CURRENT AND PROPOSED PRACTICES IN ANIMAL WASTE MANAGEMENT

by

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for the

Office of Air and Water Programs
ENVIRONMENTAL PROTECTION AGENCY

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ABSTRACT

Current and proposed practices in animal waste utilization and/or disposal were reviewed by means of a detailed search of the literature, by correspondence and by visits with active investigators in the field.

Abstracts were prepared of 1162 publications dealing with animal waste utilization and/or disposal, or closely related materials having a direct carry-over potential. These latter publications pertained to some other aspect of manure management or to thermochemical processing of some other organic material. In addition, abstracts of 111 pertinent projects sponsored by the USDA were included in a separate appendix.

Land spreading, with or without advantage being taken of the fertilizer and soil-conditioning values, is the ultimate destiny of nearly all manure produced at present. Attention was focused in the report, however, on the less-used but potentially more rewarding processes of gas or oil recovery, refeeding to animals after more or less processing, and using as a culture medium for fly larvae, worms, algae, fungi, yeast, etc., with ultimate disposal of the catabolized manure as a soil conditioner, and utilization of the organisms as feedstuffs.

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I.

CONCLUSIONS

The status of animal waste management is that of a maelstrom if not that of an inferno. Logic and delirium have both left their imprint. Fortunately, so also has the common sense which was once believed to be implicit in a rural-based citizenry.

The premise that the produce of the soil should be returned in the shortest feasible cycle to the soil has been often expressed and more often implied. And, unquestionably, land spreading of manure is a nearly universal means of its utilization and/or disposal at the present time. There are, however, difficulties inherent in the practice which may be expected to intensify and there are opportunities of deriving values by other means of utilizing manure which may lead to their adoptions under many circumstances.

TIME-RELATED FACTORS

Manure has fuel value comparable to that of lignite or oil shale. To date, only a few small installations using the methane produced in anaerobic digestion have attracted investment in competition with power supplies based on fossil fuels. The situation is changing dramatically; for large concentrations of manure, in appropriate climatic settings, conversion to oil or gas may soon be the most rewarding utilization.

Manure contains proteins, amino acids, and other nutrients which can be concentrated by various processes for direct refeeding to animals or for feeding to insects, algae or bacteria which may, in turn, become a component of feed. With continued research and further population pressures such practices may be expected to increase.

It can be anticipated that the shifting urban-rural interface will continue to absorb land which would otherwise be available for manure spreading. Moreover, the specialization of agri-business with greater concentrations of animals and separation of meat-producing and feed-producing functions may be expected to persist. These trends, in turn, require negotiations for spreading areas and involve longer hauls.

The intensified concern for controlling pollution has rendered obsolete many a practice tolerated quite recently. Odors and the possibilities of contamination of streams and groundwater are subject to regulations which will have profound effects on the choice of manure management program.

PLACE-RELATED FACTORS

For most operating conditions -- as distinguished from the total question of site optimization which includes nearness to markets, feed, and labor -- an ideal climate is one with a high evaporation potential and no sub-freezing temperatures. Artificial drying of manure is expensive; the charges for it, routinely inserted in balance sheets for thermochemical processing drawn up in humid settings, have contributed heavily to the adverse benefit-to-cost ratios reported.

Precipitation and drainage patterns should be considered carefully in planning for land disposal of manure, in that polluted runoff should be prevented from reaching streams or groundwater. Drainage of the supernatant, after detention in a settling pond, by gentle slopes to playa lakes whose bottoms have become sealed over geologic time would appear to be ideal, particularly if the runoff can be pumped for irrigation.

The density and type of surrounding development are related to the level of odor nuisance tolerable from a livestock or poultry installation and thus can influence, to a marked degree, the choice of manure utilization system.

SCALE EFFECTS

To be viable a capital-intensive installation must be large. This principle is exemplified in the hundred-thousand head feedlots and million-bird poultry operations of recent years. It may limit the applicability of thermochemical processing to areas which contain concentrations of such installations.

II.

RECOMMENDATIONS

To provide intelligent planning and guidance of manure disposal practice in the years of change foreseen as being on the immediate horizon it will be necessary to encourage research on a broad spectrum of problems. Those of highest priority are seen as being:

1. To conduct pilot-plant studies on a number of thermochemical processes for extracting oil and/or gas from the manure of beef cattle feedlots. Such plants should be in a semi-arid setting with a high evaporation-minus-precipitation value, near large concentrations of cattle on feed, in an area having existing natural gas and other petroleum developments, and having convenient sites (preferably with internal drainage) for fail-safe natural drying of manure. In such areas one would find expertise in cattle and petrochemical problems, a steady market for the oil or gas produced which would absorb the fluctuations in pilot-plant operation serenely, and a broadly-based regional self-interest in making a success of the venture.

2. To intensify studies on the refeeding of derivatives of manure and on the catabolism of manure by protein-rich larvae. Much expertise, but little funding, for this exists in the Agricultural Research Service of the USDA and on many campuses at present.

3. To provide for continued monitoring of developments in the field of animal waste utilization and/or disposal in order to make available as promptly as possible indications of significant trends. This should include the coverage of periodicals (both scholarly and trade) in many fields; the abstracting of reports of governmental, research, and other organizations; and the inauguration and maintenance of contacts with other workers in the field on a world-wide basis. To be most effective, such a program should be established at a university which has a productive record in research in many disciplines bearing directly on the problems of animal wastes.

III.

INTRODUCTION

From an airplane window Denver and Albuquerque appear to be portions of a single city with a virtually continuous grid of streets clearly visible. Further development of the megalopolis is, of course, limited to a few nodes at present.

Such "improvements," however, certainly put agriculture on notice that there will be little tolerance of odors by the future occupants or by the land developers who can allege in court that the potential value of their holdings was reduced by such nuisance. The implications for manure handling and utilization are many and far-reaching.

PREVIOUS STATE-OF-THE-ART SURVEYS

With very few exceptions the predominant utilization (or disposal) of manure involves its spreading on land with some advantage being taken of its fertilizer value and/or its soil conditioning value. The early literature (of which only a few samples are abstracted in Appendix A) dealt almost exclusively with analysis of fertilizer values of manure and litter from various sources applied to specific crops grown in specific soils under specific climatic conditions.

As the problems of intensified concentrations of animals on feed and of encroaching suburbia became apparent, students of the problem investigated other possibilities. On balance, however, and with more or less reluctance, most of them concluded that land spreading was the optimum destiny of manure.

BLACK [1967-1002]*, in seeking solutions pertinent to Ontario, weighed the merits of composting, anaerobic digestion, aerobic treatment, and lagooning. He concluded that despite the difficulties involved when livestock and crop producers are distinct, and with the crop producer able to use commercial fertilizers at less cost than "free" manure, ". . . the application of manure to soils is well justified and desired."

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*Numbers in square brackets refer to abstracts in the appendices. The first four digits are the year of publication. A "1" after the hyphen indicates that the abstract appears in Appendix A; a "B" or a "C" indicates Appendices B or C. Within each appendix the arrangement is chronological, then in ascending order of the last block of three digits.

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LOEHR [1968-1027, 1969-1045], in a well-documented penetrating survey of the state of the art of manure utilization, observed that little study had been given to any aspects of the age-old practice of land disposal other than crop response. He accorded detailed consideration to a number of alternatives to land disposal -- anaerobic digestion, aerobic treatment, anaerobic lagoons, anaerobic-aerobic systems, incineration and drying, and miscellaneous processes which, "because of technical or economic difficulties, . . . have not found wide application."

WADLEIGH [1968-1042], in a frequently cited study of the disposal of the wastes from agriculture and forestry, observed that the cost of transportation of manure frequently exceeds its value as fertilizer and advocated the study of the possibilities of utilizing manure as a culture medium for the propagation of organisms antagonistic to known plant pests and diseases. He also recommended the combination of agricultural and industrial wastes as an effective soil amendment.

JONES [1969-1039], speaking at the first of the annual conferences on agricultural waste management at Cornell University, discussed the by-then usual list of alternatives and predicted that the future would include greater urban sprawl and more rural non-farm residences. "Man-made" land renovated by sludge disposal and contracted manure handling services were considered to be possibilities.

MOORE [1969-1061] classified the management of manure into four distinct steps: collection, storage, treatment, and utilization or disposal. This latter was primarily to the land. MOORE and BROOKER [1970-1071], looking into the future, predicted that improved rations can be expected to produce a richer manure which may be refed or may become a source of nutrients, antibiotics, and vitamins. Lagoons may well be replaced by digesters with these latter being warmed by burning the gas they generate. They foresaw the raising of livestock in complete confinement with no runoff, and anticipated rural zoning separating town and feedshed with several miles of cropland, partly irrigated with animal wastes.

DALE [1971-1064] surveyed a number of means of waste disposal and concluded that, at least until the size of operation increases, return to the soil "appears to be the more feasible way to handle dairy cattle wastes." YECK and SCHLEUSENER [1971-1272], in a paper presented at the same symposium, observed that land recycling was the current best practice. They then discussed sixteen alternatives which could well prove to be preferable when operations are large, land is scarce, or neighbors are fastidious.

The Canada Committee on Agricultural Engineering issued a guide [1972-1022] designed "to bring together the current practices that provide reasonable approaches to handling animal wastes." Land recycling was emphasized.

GOLUEKE [1972-1053, 1054] evaluated ponding and its refinements, digestion, composting, land disposal, refeeding, pyrolysis, and assorted fermentations under the felicitous title, "Changing from Dumping to Recycling." HODGETTS [1972-1069], in surveying American waste disposal practices for a British readership, observed that "land spreading is still, of course, generally the cheapest, most efficient and most popular means of disposing of animal manures, but the economic cost of doing this may in some cases be so high as to make the system unattractive." He was particularly intrigued by the research in the catabolism of manure by fly larvae and the subsequent feeding of the protein-rich larvae, pupae, or adult flies to chickens.

SHUYLER [1973-1030] saw the high-priority research needs in the animal feedlot program as being "1) the need to develop techniques for reprocessing and converting animal wastes into a usable product. . . [and] 2) the urgent need to make the current information on animal waste management readily available for widespread use by governmental agencies, the feeding industry, and researchers in the field. . ." The processes he considered to be currently promising include conversion to some type of fuel, feed or additive for animals, or other by-product. The present investigation, nearing its final phase when SHUYLER's study appeared, reached the same conclusions independently.

SOLID WASTE STUDIES

Animal wastes have usually been considered to some extent in general surveys of solid waste disposal. However, manure is more uniform and tractable, and the nuisance created by it becomes of direct personal concern to far fewer people. Thus, its handling problems tend to be glossed over in these general studies. There is, however, much of transfer value in the discussion of methods tried or proposed for the management of municipal refuse, and a perusal of the well-documented studies of GOLUEKE and McGAUHEY [1970-1029, 1030; 1971-1106; 1972-1106] and of the series of solid waste bibliographies by CONNOLLY and STAINBACK [1971-1059; 1972-1024 through 1027] can be rewarding.

PREVIOUS BIBLIOGRAPHIES

MINER has prepared a brief discussion of the literature on animal wastes for each previous year as a portion of the annual literature review of the Journal of the Water Pollution Control Federation each year since 1968 (review of 1967). In addition, he prepared bibliographies for Iowa State University [1972-1111] with JORDAN and for the EPA [1972-1110] with BUNDY and CHRISTENBURY.

McQUITTY and BARBER [1972-1107] prepared a monumental volume containing abstracts of 2352 articles on farm animal wastes. Their coverage is wider than that of this report since they did not emphasize the utilization and/or disposal, but covered the entire field. Some of their citations were used in the writing of the body of this report, but the publication appeared too late to be used in extending the bibliography in Appendix A. Their very comprehensive index makes this work extremely useful.

JOHNSON and MOUNTNEY [1969-1037] published a bibliography on poultry manure with 596 entries and MUEHLING [1969-1064] prepared an excellent monograph on swine housing and waste management which included 155 references.

ORGANIZATION AND OBJECTIVES OF THIS REPORT

A study of the management of animal wastes, as mentioned earlier, would involve consideration of four operations: collection, storage, treatment, and utilization or disposal. Any effort to optimize an operation will, of course, require that attention be given to all four components. It was not the objective of this report, however, to prepare a self-contained treatise on animal waste management. On the contrary, the purpose here has been to provide a guide to facilitate research into the utilization and/or disposal of manure. Thus, in the interests of brevity, no organized discussion of the collection or storage of manure has been prepared and methods of treatment are considered in some detail only because they are often so intimately associated with utilization or disposal that no indisputable boundary could be established. This lacuna is filled to some extent by the abstracts.

LAND SPREADING

As mentioned earlier in this chapter, the predominant method of utilization and/or disposal of animal wastes is by land spreading. The previous state-of-the-art reports cited treat the subject comprehensively as do many specialized papers listed under "Land Spreading" in the index to be abstracts.

The deficiencies in research referred to by LOEHR [1968-1027] are being remedied. In particular, studies of optimum and of maximum non-damaging application rates of manure to land are reported in many of the recent papers abstracted. In view of the abundance of readily-available treatments of the subject, no detailed discussion of it will be offered here.

OTHER METHODS OF UTILIZATION AND/OR DISPOSAL OF MANURE

The other methods of utilization and/or disposal of manure have been classified in this report as microbiological, macrobiological, and thermochemical and discussed in chapters IV, V, and VI, respectively. The microbiological processes are frequently treatment methods rather than means of ultimate disposition.

ENVIRONMENTAL CONSIDERATIONS

The economic incentive for seeking alternatives to land spreading is to be found in long hauls, requirements of storage between periods when spreading is feasible, separate ownership of feedlots and croplands, competition from artificial fertilizers, and risks of saline or other damage to some crops in some circumstances. In addition, land spreading and some of the other methods of disposal, as well, involve potential pollution of air, water, and/or soil. References to a large number of papers discussing various aspects of environmental quality may be found under the headings: Air Pollution, Odor Control, Fly Control, Groundwater Pollution, Runoff, Nitrates in Soil, Salt, Pathogens, and Toxicity in the index to the abstracts [Appendix D].

DRYING OF MANURE

An all-pervasive topic in manure management is the moisture content of the manure. It affects both the pollution potential and the cost of handling.

Water, recycled or from some other source, is often added to manure to facilitate its handling as a slurry [see abstracts cited under "Liquid Manure Handling" in the index, Appendix D]. This practice introduces a secondary problem in that an additional volume of material will have become polluted and should be used, or otherwise disposed of, without risking contamination of surface streams or groundwater.

Dewatering, a rather loosely defined term used here to designate mechanical means of separating liquids from solids, has been accomplished by vacuum filtration [CASSELL et al, 1966-1013], by electro-osmosis [CROSS, 1966-1017; NURNBERGER et al, 1966-1056], by centrifugation [ROSS et al, 1971-1219; SENIOR, 1973-1029, 1043], and by use of a screw press [MENEAR and SMITH, 1973-1023]. MENEAR and SMITH, using manure from dairy cattle, found the crude protein content of the liquid portion (on a dry basis) to be 49.6 percent. SENIOR's process is reported to recover 315 lb of protein per net ton of manure. Of this, about 240 lb are obtained from the liquid portion and the balance is available from the fibers retained by the centrifuge.

The disposal of poultry manure is facilitated by drying in that the drier manure is more convenient to handle, is less odiferous, and occupies less volume. RILEY [1968-1033] describes eight makes of heat dryers for poultry manure available on the British market.

SURBROOK et al [1970-1092, 1971-1238] report the price per ton of manure, dry basis, for a commercially-produced, on-the-farm dryer for poultry, bovine, and swine wastes. SHANNON and BROWN [1969-1077] tabulate the losses in energy and in nitrogen content which result from the drying of poultry manure by various procedures. THYGESON et al [1971-1249, 1250] reported on experiments in which superheated steam was used to dry pelletized manure.

BRESSLER [1969-1012; 1970-1010; 1971-1035, 1036, 1149; 1972-C012] has perfected a two-stage drying operation in which the moisture content of poultry wastes is reduced from 75 percent to 30 percent by stirring in the poultry house and from 30 percent to nine percent in a commercial dryer. The final weight is one-third of the original. Costs are stated to be less than $4 per ton.

MAYES [1972-C067] states that the cost of dehydration is about equal to the wholesale selling price of dehydrated manure. Despite the dust and odor associated with dehydration, he finds that it may often be the preferred solution. BERGDOLL[1972-1014] estimated drying costs to be about six to eight dollars per ton of dried product. Total costs, including transportation to the dryer, would be about $15 to $35. PRICE [1972-1127] stated the cost range for drying to be about $6 to $7 for European conditions, and valued dried poultry waste at $18 per ton as poultry feed, and somewhat higher as feed for ruminants.

The drying of manure by evaporation occurs at a rate substantially less than that from a free water surface. In arid and semi-arid climates, however, natural drying may permit the safe use of simplified methods of manure management [WELLS et al, 1971-1258]. Moreover, the effects on costs are such that conclusions reached using values for humid regions may be inapplicable elsewhere. This line of thought will be pursued further in the discussion of costs of thermochemical processes (Chapter VI).

IV.

MICROBIOLOGICAL PROCESSES

The treatment of human sewage is accomplished by processes which are predominantly microbiological. What, then, would be more reasonable than to apply the same procedures, with appropriate modifications, to animal wastes? Pursuing this line of thought we risk treading the path of the prophets of doom with their astronomical figures for population equivalents in the calculation of livestock wastes and their exhortations that salvation for mankind on earth lies in the soybean.

Fortunately, manure isn't sewage. As has often been pointed out, the one is a very dilute suspension of solids in water while the other is a slurry which may be diluted for convenience of handling but only with acceptance of the penalty of having a larger polluted mass to dispose of. There are some valid parallels, however. Manure in its undiluted state is somewhat similar to sewage sludge and responds similarly to anaerobic treatment -- with, unfortunately, risk of odor production. Diluted and aerated, it can be stored for more timely spreading. The details are best developed in conjunction with a review of the literature.

ANAEROBIC TREATMENT

The bacteria capable of decomposing organic substances anaerobically are found universally in nature, particularly in decaying matter. In the decomposition they produce methane and other gases and a stabilized sludge with a fertilizer value nearly equal to that of the original material.

MICROBIAL PRODUCTION OF METHANE

Several papers in the Comptes Rendus de l'Académie d'Agriculture [1946-1001, 1951-1001, 1952-1001] attest to the activity in the application of microbially-produced methane for on-premise power production in France and Algeria in the post-war years. Some 500 to 600 small plants existed in France and FERAUD observed that the nation's manure contained a potential thirty trillion calories of energy. For comparison, the total French energy production in 1938 was 230 trillion calories.

WINTERS [1957-1002] reported on the powering of a farm in South Africa with methane. He found pig manure to be twice as productive as cattle manure. FREY [1961-1006] described a power plant he built in South Africa in 1958 in which the methane released from the

1600 lb of dung produced daily by 700 pigs yielded sufficient electricity to power the farm and three houses free of all fuel costs. Cooling water pipes conveyed waste heat from the engine through the digester.

HUTCHINSON [1962-1006] operated a coffee plantation in Kenya on methane. Ten years' land application of the residue, as his sole fertilizer, doubled his coffee yield.

Other indications of interest [1961-1009, 1967-1018] appeared in the 1960's but ALLRED [1966-1002] observed that methane utilization had ceased in northern Europe.

PFEFFER [1971-1206] studied the potential for energy reclamation from solid wastes under an EPA grant during 1969-1972. LAURA and IDNANI [1971-1148] tested the efficacy of various additives to manure to increase the methane production. They found urine and dried leaves to be effective.

COSTIGANE et al [1972-1029], in an intensive investigation into the theory and feasibility of anaerobic digestion, concluded that the most economical and efficient design for methane production and waste stabilization "is not at present considered feasible for animal waste treatment on a small farm due to the high initial equipment cost." They recommended, however, that further investigation be pursued toward reducing the initial capital cost and they proposed also that financial analyses be made for a farm community and for cattle feedlots of various sizes. Based on this study, P. L. SILVESTON and J. M. SCHARER of the University of Waterloo submitted a research proposal to Environment Canada in November 1972 for funding a prototype plant for a family farm of about 100 dairy cattle.

SAVERY and CRUZAN [1972-1135] conducted tests on an experimental anaerobic digester for the production of methane gas from chicken manure. Their calculations indicated that a 60,000-chicken unit would supply enough methane to be self-sufficient in its total electricity requirement, but at a cost six times that of its present supply. They considered that improved technology and the then-impending shortage of natural gas should reduce the adverse cost-to-benefit ratio.

A somewhat similar, but economically more attractive, study by HALLIGAN and SWEAZY [1972-1060] will be discussed in Chapter VI.

ANAEROBIC DIGESTION

Anaerobic digesters, as we have seen, produce methane. They also produce an easily dewatered free-flowing liquid sludge with a soupy texture, inoffensive odor, and essentially undiminished fertilizer value. TAIGANIDES et al [1963-1012], in an assessment of sludge digestion, cited these advantages and also mentioned a reduction (by 50 to 75 percent) in organic content of the waste, a stabilization preparing the residue for ultimate disposal in a lagoon or on land, and a lack of attractiveness for flies and rodents. Their list of disadvantages include a high capital cost, the necessities of sludge disposal and of daily supervision, and the possibility of explosions. HART [1963-1007] considered digesters to be a feasible and desirable means for treating chicken manure at a reasonable cost.

GOLUEKE [1971-1106] observed that little volume reduction results from anaerobic digestion. GRAMMS et al [1971-1110] have proposed ultimate disposal of the sludge by land spreading, composting, or burning. KLEIN [1972-1079], working on the problems of solid waste disposal, recommended that anaerobic digestion be employed only for the reduction of putrescible organic wastes -- including manure.

ANAEROBIC LAGOONS

DORNBUSH [1970-1018], reporting that properly designed anaerobic lagoons will control odors and stabilize wastes, described the mechanism of the treatment as involving two stages. In the first stage the organic matter undergoes breakdown with little reduction in BOD or COD; in the second, methane and CO_2 are released and the waste stabilizes. The effluent, however, will require further treatment. Design criteria are empirical and highly temperature-sensitive.

Unless loadings are kept low, or other precautions are taken, farm lagoons will be anaerobic. An anonymous study [1963-1014] cautioned that aeration is futile since an acre of water surface would accomodate only 1200 chickens or 50 hogs while remaining aerobic. The combination of an anaerobic lagoon with the supernatant flowing to an aerobic lagoon was considered to be excellent.

CURTIS [1966-1018] and WILLRICH [1966-1076], basing their recommendations on studies in South Dakota and Iowa, proposed design criteria for anaerobic lagoons. LOEHR [1967-1012, 1968-1026] observed that anaerobic lagoons are essentially septic tanks and proposed design criteria for them. The MIDWEST PLAN SERVICE [1969-1055] issued a two-page guide for their design and operation.

PFEFFER [1970-1076] described the mechanism of their operation as consisting of an acid fermentation followed by a methane fermentation, and likened it to that of the bovine rumen.

PARSONS et al [1970-1075] proposed design specifications for a poultry lagoon, suggesting that it would be prudent to construct one only in a rural area tolerant of odors. WHITE [1970-1106] found that state regulations were usually vague on the subject and that descriptions in the literature were often incomplete and failed to employ a standard set of parameters.

FEE [1971-1087] and KOELLIKER et al [1972-1082] describe the anaerobic lagoon in use at Iowa State University for an 800-head hog finishing unit. Water from the lagoon is recirculated for flushing, and the excess is employed for irrigation. In nine years of operation no lagoon cleaning had been required.

HAZEN [1971-1125] found that an anaerobic lagoon with 3.5 to 5 lb of volatile solids per 1000 cu ft provided satisfactory preliminary treatment for hog wastes. SHINDALA and SCARBROUGH [1972-1141], disposing of hog wastes in Mississippi, recommended that the lagoons be regarded as being only the first step in treatment. BARTH [1972-1011, 1973-1002], based on laboratory investigations in South Carolina, found them to be "dependable, low-cost, and successful."

SMITH [1972-C089], studying infiltration rates in anaerobic lagoons treating swine wastes in Georgia, observed a decrease from two feet per day in 1969 to a half foot per day at the end of 1971.

NANSON [1972-C078] is studying strains of bacteria capable of growth using methane as their sole carbon and energy source. He is also seeking useful products obtainable from methane.

AEROBIC TREATMENT

Secondary treatment of sewage is aerobic. Thus a wide variety of aerobic processes came readily -- perhaps too readily -- to mind when sanitary engineers first gave serious thought to the pollution potential of manure.

CONVENTIONAL SEWAGE TREATMENT

PELLET and JONES [1946-1003] reported that, with the extension of piped water to rural areas in Britain, consideration was given to reducing the potential pollution of cowshed washdowns by including them in the inflow to sewage treatment plants. KEEN [1969-1040] observed that discharges of animal wastes to sewers had been quite common in the United Kingdom until an Act of Parliament in 1961 permitted cities to assess charges and refuse loads. Discharge to streams being forbidden, this imposed serious burdens on some farmers. The position taken by the responsible authorities [1969-1091] was that waste disposal must be regarded as a production cost.

Spokesmen for the farmers' union [1969-1090, 1971-1108] advocated provision for the disposal, at least of supernatant, to sewers. They pointed out that land spreading in a damp climate leads to runoff to streams and that reliance on it results in delays due to mud and freezing. Anaerobic stabilization was not considered to be a viable alternative. SIDWICK [1972-1142] deplored the slug loads, often including straw, which reach sewage treatment plants in Britain from cattle markets.

JAWORSKI and HICKEY [1962-1007], discussing American practice in cage washing, reported that water for all but the final rinse is recycled. When the final rinse water, drawn from potable mains, drains to the recycling tanks an equivalent volume is released to the sewer. MacDONALD and DAVIS [1966-1045] observed that fixed zoos tend to use municipal sewers and they tabulated BOD measurement for various animals at New Orleans. Primates which have been used for studies of human diseases pose critical problems. FRITSCHI and MacDONALD [1971-1096] reported that the BOD of wastes from primates was three to six times as high as that from humans. Heavy chlorination is employed at sewage treatment plants handling their wastes.

JOHNSON [1965-1013, 1014, 1015] proposed modified septic tanks (anaerobic) for treatment of manure from dairy cattle and poultry. Methane generated would be burned to heat the digesters and flushing water would be reused. He described a pilot plant serving a 7000-bird operation in Massachusetts.

WEBSTER and CLAYTON [1966-1074] built bench and pilot-scale models of activated sludge plants for treating dairy wastes. BRIDGHAM and CLAYTON [1966-1010] observed that trickling filters may be used to treat dairy manure. Neither paper gave cost data.

SMITH [1972-C088] is investigating the performance characteristics of inclined-plane trickling filters for the treatment of swine wastes. CROPSEY and WESWIG [1972-C020] are investigating the use of Douglas fir bark as a trickling filter medium for poultry wastes. LOEHR and ZWERMAN [1972-C061] have investigated the applicability of sanitary engineering fundamentals to the design of aerobic biological treatment systems for animal wastes.

DUCK WASTES

Ducks pose serious pollution problems because of the relatively large volumes of water employed in raising them and the potency of their wastes. HOVENDEN [1970-1038], discussing this latter point, chose for title, "Coliformally Speaking, Ducks Stink." GATES [1963-1005] described procedures instituted on Long Island where duck farms were polluting shellfish and recreational areas. The use of water per duck was cut to ten gpd from a previous 25 to 75, sedimentation ponds were installed, and chlorination was begun. Sludge disposal from the sediment traps is difficult to schedule and supervise.

DAVIS et al [1966-1020] reported the adoption of two sediment basins, used alternately, below a duck farm in Virginia. This solution reduced coliforms by 90 to 95 percent and permitted the resumption of oyster harvesting downstream.

LOEHR and SCHULTE [1970-1053; 1971-1222, C060] proposed a five-day retention in an aerated lagoon of the slug flows of duck manure washed into the water by precipitation. An additional settling pond and final chlorination were also called for. Cost reduction was seen as being attainable only through reducing the water usage.

AEROBIC LAGOONS

JONES, DAY, and DALE [1972-1075] have prepared a comprehensive, readable, and well-documented up-to-date study on aerobic treatment of livestock wastes. In it they reviewed the theory of aerobic treatment, discussed oxidation ditches at some length, and set out design criteria for oxidation ponds and for mechanically-aerated lagoons. They recommend that ultimate disposal be by irrigation.

The use of indoor lagoons under poultry has been the subject of a number of papers. AL-TIMIMI et al [1964-1001, 1965-1001] reported that neither heat, air, nor any combination of them was effective in reducing the solids content in such lagoons. They recommended a volume of 3.5 cu ft per bird as being adequate with biennial cleaning. HOWES [1968-1023] reported a fifty percent reduction in bulk in a pit inoculated with aerobic bacteria. He had disturbed the surface cake weekly in winter and twice weekly in summer. The resulting sludge was an odorless fertilizer usable in urban gardens. CABES et al [1969-1016] and BARR et al [1970-1128] reported that an indoor poultry lagoon at Louisiana State University was proving to be effective. The lagoon effluent flowed, by means of an open ditch, fifteen hundred feet to a fish-inhabited bayou. Both fish and hens were doing well. VICKERS and GENETELLI [1969-1082], praising oxidation tanks for the odorless fly-free effluent they can produce with a minimum of maintenance and operation, advocated separating the liquids and solids and then applying them to the land. C. H. THOMAS [1972-C097] reported that in four years operation an aerated lagoon under poultry in Louisiana had accumulated seven lb of solids per hen per year with no odor problems resulting.

DALE [1968-1012] observed that aeration can almost eliminate odor from dairy cattle wastes, but mentioned that degradation is slow.

BERRY [1966-1008] recommended that aerobic lagoons in cold climates be agitated, supplied with oxygen, diluted, and heated. NYE et al [1971-1189] stated that oxygen must be supplied to accomplish the aerobic decomposition of dairy cattle manure. The reduction in COD was better at high temperatures. PRATT [1972-C081] found that a lagoon in Fargo would remain aerobic except in winter. BARTH and POLKOWSKI [1971-1020] suggested that only the surface layer of lagoons be aerated over the winter. Such a practice reduces operating costs, improves nutrient recovery, and allows the reuse of the supernatant for flushing.

BLOODGOOD and ROBINSON [1969-1010] observed that aerobic storage before land spreading minimizes odor problems. OGILVIE and DALE [1971-1190] noted that aeration for less than 24 hours may be effective in rendering manure relatively odorless. They suggested, however, that an additional aerated lagoon be added in areas subject to freezing.

DALE et al [1969-1023, 1971-1063] floated a guyed aerator in the center of a pond and irrigated cropland with the effluent at a maximum solids content of two to three percent. They reported the system to be odorless, inexpensive, and universally applicable. It saves nutrients, minimizes runoff, lowers potential pollution, and requires little labor. GILLILAND [1970-1028] cited cost data for a similar installation. TEN HAVE [1971-1247] observed that surface aerators with vertical shafts have less trouble with bearings than do oxidation ditch rotors and for this reason aerated ponds are replacing oxidation ditches in current Dutch practice.

OXIDATION DITCHES

Oxidation ditches have been discussed so exhaustively in the literature that it seemed pointless to add yet another analysis of their behavior here. Thus, with the exception of the subtopic of refeeding of oxidation ditch residue to animals, which is treated in Chapter V, the subject is being dismissed with the suggestion that reference be made to the index to the abstracts and to JONES, DAY, and DALE [1972-1075] for information on them.

COMBINED OR SEQUENTIAL ANAEROBIC AND AEROBIC TREATMENT

Most bacteria are neither strict aerobes nor strict anaerobes; they are facultative. Moreover, ponds tend to stratify with the oxygen content decreasing with depth. Thus waste stabilization is often facultative in fact and occurs in ponds in which the boundary between aerobic and anaerobic portions shifts with the seasons.

As was observed by JEFFREY et al [1965-1012], aerobic lagoons as a sole treatment device are economic only if the feeder happens to possess a large pond. (The Canada Animal Waste Management Guide [1972-1012] cites the surface requirement as 19 acres for 1000 hogs, mentions that 15 million [imperial] gallons of water would be required for initial filling, and adds that "it is also doubtful whether the relatively small volume of manure added would maintain a satisfactory liquid depth in the lagoon.") A series of ponds, with the first one being anaerobic, was proposed as being a promising alternative.

For the handling of manure from beef cattle feedlots AGNEW and LOEHR [1966-1001; 1967-1014, 1026; 1969-1047] advocated the combination of an anaerobic lagoon located in the vicinity of the feedlot followed by an aerobic lagoon for the treatment of the effluent. If the liquid is to be released to streams it would be prudent to add a second aerobic lagoon for final polishing. The cost of the series of two or three lagoons may be moderate since the operator often possesses the excavating machinery required. The digested solids may be handled by pumping for land spreading at appropriate times, and the effluent may often find application for irrigation or other non-potable uses.

Successful applications of lagoons in series have been described [1969-1008, 1013, 1021; 1971-1186] as was an interesting variation [1971-1312] consisting of an anaerobic lagoon with thirty-day detention time for the treatment of hog wastes followed by an oxidation ditch which produces an effluent claimed to be "cleaner than most industrial or municipal wastes." The ditch effluent is discharged to the Fraser River, one of British Columbia's most productive salmon streams.

BARRETT [1971-1018] advocated a two-pond system in which "settled liquor is drawn from the deep section by a centrifugal pump and sprayed over the shallow section to aerate it with inspirated air." Overflow would pass back over a weir into the deeper section. He commented that electrolytic floatation might aid in the effluent treatment.

AN EVALUATION OF LAGOONS

EBY [1962-1003] diagnosed early that manure lagoons are no cure-all. They are not applicable where land is unavailable or too porous, where water is scarce, where danger of pollution of streams or groundwater exists, or where land is too expensive. They are subject to malfunctioning caused by floating bedding, litter, and feathers; overloading; intermittant loading; aquatic weeds; and sludge build-up.

PALMER [1964-1013], reporting on a seven-paper ASAE Symposium, stated that "all the speakers agreed that lagoons, as a means of ultimate manure disposal, had been overrated and under-built." CLARK [1965-1006], in a report of his investigations of lagoons for hog wastes in Illinois, observed that "never were the complaints found to be unjustified." HART and TURNER [1965-1011] emphasized the dangers of infiltration and the nuisance of odors. OSTRANDER [1965-1018] added the frustrations of freezing.

PONTIN and BAXTER [1968-1032], concerned primarily with British conditions, advocated pretreatment of manure prior to land-spreading and discussed the relative merits of digesters, oxidation ditches, and lagoons. HART [1970-1032], reflecting the improvements which resulted from the investigations of the 1960's, concluded that "lagoons and oxidation ditches are not magic wands, but they can be very reasonable manure processing units." This appears to be a fair summary of their current status.

COMPOSTING

The principles and history of composting have been summarized in two very readable papers by GOLUEKE [1972-1054, 1055]. While the process can be either aerobic or anaerobic and in either the mesophilic or thermophilic temperature ranges, modern preference tends to be aerobic to mitigate odor nuisances and to be thermophilic to enhance the probability of killing pathogens and weed seeds. Moreover, these choices of operating conditions speed the composting process. Aeration, moisture content, temperature, carbon-to-nitrogen ratio, and particle size are the principal parameters governing the process.

HART and SCHLEUSENER [1963-1008], in summarizing an ASAE symposium, observed that while manure is too moist for successful composting and garbage is too dry, too low in nutrient, and too bulky, a proper mixture may prove to be ideal. BELL [1971-1024] added the caution that trash and salt should be avoided in combining municipal and agricultural wastes for composting. WILEY [1963-1013] proposed the addition of sawdust to compost poultry wastes effectively. GALLER and DAVEY [1971-1098, 1099] reported that such compost makes a good soil conditioner.

HARTMAN [1963-1009] recommended composting of poultry manure as an economical means of fly control. He suggested semi-annual pit cleaning leaving a six-inch layer of manure. LIVSHUTZ [1964-1011] gave cost data for the composting of poultry manure employing forced aeration of windrows covered with plastic sheets to prevent top drying by sun and wind and wetting by rain and snow. EASTWOOD et al [1967-1005] reported that twice-weekly turning of windrowed poultry manure compost eliminated flies. Fully-composted manure is unattractive to flies.

WELLS et al [1969-1086] found composting to be an effective method of handling wastes from the beef cattle feedlots of the High Plains of Texas. While large numbers of fly larvae appeared during the first week, they were killed by the heat generated in a weekly turning program. The material stabilized sufficiently rapidly to be vermin-free in less than ten days. GRUB [1971-1117] observed that skilled management is required to obtain satisfactory results in the composting of beef cattle feedlot wastes.

BELL and POS [1971-1026, 1027] reported indifferent success with the composting of poultry manure in Guelph, Ontario. They were, however, able to operate throughout the winter.

WILLSON and HUMMELL [1971-1265, 1972-1168] deduced a set of rules for the optimum composting of dairy cattle manure. SCHULZE [1972-1194] developed methods for continuous composting and presented cost data.

HOWES [1966-1037] observed that poultry litter can be renovated by proper composting in place. Such practice would be useful after floods or after diseased birds. PATRICK [1967-1019] and SMITH [1967-1021] advocated the composting of litter to destroy microorganisms. HANKS [1967-1006] questioned the effectiveness of operational, as contrasted to laboratory, composting in the elimination of pathogens and PETERSON [1971-1205] expressed concern over the potential hazard of a residual pathogen content.

YEATMAN [1970-1108] reported that the Pennsylvania mushroom crop of 125 million lb utilizes 400,000 tons of compost per year. The spent compost is still a good soil conditioner. SINKEVICH [1973-1031] added that the preferred compost is made from horse manure from local racetracks or even, in winter, by shipment from New Orleans to Pennsylvania. An acceptable substitute can, however, be made from chicken manure.

FERMENTATIONS

GOLUEKE [1972-1054] summarized the potential of assorted fermentations as follows:

> "A variety of fermentations and biological hydrolysis systems have been developed for breaking down cellulose to its constituent glucose units. The glucose is used as a substrate for the production of yeasts which can be incorporated into livestock feedstuffs. These processes are largely in the research stage. At present, the economics of the processes are highly unfavorable."

SINGH and ANTHONY [1968-1034] separated manure from concentrate-fed steers into solubles and fiber. The solubles, which on a dry basis constituted 68.57 percent of the manure, were inoculated with yeast, incubated, and dried. The crude protein content of the resulting yeast product was 40.9 percent (dry basis). The mineral content was too high, however, to permit its effective use as a feed. MOORE and ANTHONY [1970-1070] by adjusting the pH of fermenting cattle manure daily for three days with ammonia raised the crude protein level from 16.99 to 43.26 percent and increased the amino acids by over 20 percent. ANTHONY et al [1973-1001], reporting on the results of fermenting mixtures of cattle manure with forages or hulls, observed that the mixture will have high nutritive value only if it is maintained at a pH near 4. Further investigations are underway [1972-C003].

MELLER [1969-1054], in a 173-page study devoted primarily to the conversion of municipal wastes, waste paper, and bagasse by fermentation, placed the cost of the process "at best at the high end of the current high protein supplement price range." KEHR [1970-1042] stated that a two-stage hydrolysis-fermentation process holds promise. Further study would be required to obtain cost estimates.

JACKSON et al [1970-1040] attempted to circumvent the toxicity of uric acid for poultry by fermenting poultry manure before refeeding it. HAMILTON et al [1971-1118] experimented with fermentation as a means of improving the quality of manure as a feed.

CALLIGHAN and DUNLAP [1971-1046] converted bagasse to bacterial single-cell protein by fermentation and reported the preliminary economic data to be encouraging. THAYER [1971-1282, 1288] "has shown that feedlot wastes can be used both as a cellulose and a nitrogen source for conversion of it and other waste into a complete cattle feed with a single cell protein base." What cannot be converted is used as roughage. SWEETEN [1973-1042] observed that fermented mixtures of fresh feedlot manure and roughage improve the rate of gain and feed efficiencies of beef cattle.

CREGAR et al [1973-1008] ensiled broiler litter based on pine shavings to produce an effective pathogen-free cattle feed with negligible drug carryover. HARMON et al [1973-1012] tested ensilages of various proportions of broiler litter with corn forage at two different states of maturity.

WALDROUP [1973-1038] established that, with proper precautions, yeast may constitute 20 percent of a chick's ration. Algae, however, is perhaps preferable. LaSALLE and LAUNDER [1969-1042] proposed to ferment chicken manure in a weak phosphoric acid solution maintained in catch troughs, to extract the proteins and carbohydrates for feedstuffs, and to use the residue for fertilizer. They estimated the gross profit of the operation to be $14.50 per ton.

GENETELLI [1972-C033], KLOSTERMAN and McCLURE [1972-C051], NANSON [1972-C078], and RHODES [1972-C084] are investigating various aspects of manure fermentation under USDA sponsorship.

GENERAL ELECTRIC'S STUDIES

In October 1971, Feedstuffs announced, crediting as its source of information Pfizer Feeder Facts, that an unnamed concern from outside the field of agri-business was reported to be about to erect a pilot plant in the Southwest in which thermophilic microorganisms would convert cellulose and lignin to microbial protein which could be used as animal feed. In April 1972, Feedstuffs [1972-1202] announced that the pilot plant would open in the summer of 1972 after years of preliminary research. The May issue of Feedlot Management [1972-1196] carried a mock-up and a flow diagram of the plant plus a column of explanation of the process. In October, Beef [1972-1184], CALF News [1972-1100], and the Water Resources Newsletter [1972-1224] announced the opening of a pilot plant in Casa Grande, Arizona, in which the wastes from 100 head of cattle would be digested by thermophilic bacteria to produce a cellular mass, high in protein, which would be dried then used as a feed supplement for cattle. The results of FDA studies of the project were expected by mid-1973. MANTHEY, writing in Feedlot Management for October [1972-1100] gave the most extensive account which has come to the writers' attention. After observing that "the reclamation system provides a bonus in that it turns out to be a protein multiplier -- it harvests 1-1/2 lb of protein for every pound that is fed into it in the form of animal wastes," MANTHEY quotes rather extensively from various officials of General Electric associated with the project. The November Issue of Environment News [1972-1192] reported that 120 lb of feed were being produced daily from the 340 lb (dry basis) of manure supplied.

Inquiries in Phoenix in May, 1973, led to the information that the pilot plant had been placed on a standby basis while further work was being rushed at the laboratory. The thermophilic bacteria, it appears, had not adjusted satisfactorily to pilot-plant scale operation. A paper was presented orally on the process at a meeting of the AIChE in June, 1973, but copies had not been made available when this report was written several weeks later.

THE HAMILTON STANDARD PROCESS

Several of the papers cited on the General Electric project also mentioned a somewhat similar study being pursued by the Hamilton Standard Division of United Aircraft Corporation. In the Hamilton Standard process [1973-1045, 1048], manure is slurried, heated and fed continuously to a fermentation tank in which anaerobic bacteria operating in the thermophilic temperature range convert it to methane, carbon dioxide, and a solid residue which can be dried and used as an ingredient of feed. Alternatively, the residue may be coated with resin and pressed into board or used as a nutrient for a fungus that produces a fiber-digesting enzyme which may be used to improve the digestibility of poultry feed. For an operation involving 5000 to 7000 or more head of cattle, the methane produced from the wastes would be sufficient to provide all the heat and power required for operation.

TURK [1972-C099], in a progress report on an ARS-sponsored study of the process stated that

> "cattle feedlot waste at 10% solids concentration can be digested in continuous anaerobic fermentation at feed rates between 0.5 and 1.0 pounds of volatile solids per cubic foot digester per day with a residence time of 6.25 days. The optimum temperature is 49°-51°C. A 40-60% reduction of solids occurs with 90-95% of carbon in the input accounted for in the gas + output solids. No significant loss of nitrogen occurs in the gas. Methane production is 3-4 cubic feet per pound volatile solids introduced. The gas is consistently 50-52% methane; the remainder is CO_2. Hydrogen is not produced. . . Digestion and gas production have been consistent for 9 months of continuous operation."

OTHER MICROBIOLOGICAL INVESTIGATIONS

ANDREWS and KAMBHU [1971-1012], after completing a theoretical analysis of the steady-state operation of thermophilic anaerobic digestion of organic wastes, suggested its application to the disposition of sludge resulting from the treatment of sewage containing ground garbage. Their 76-page report, with its 55 references, contains much of interest for manure disposal.

CARLSON [1971-1051], in describing the Babson Biochemical Recycle Process, reported that it separates cattle wastes into squeeze-dried solids of a quality usable as bedding and roughage and a liquid which may be "processed to any degree of purity desired by ion-exchange and charcoal treatment, and also ultra-violet exposure if potable water is desired."

Enzyme-facilitated microbial decomposition of cattle feedlot manure was discussed by ELMUND et al [1971-1084]. A brief note in Poultry Digest [1973-1051] reported that a fiber-digesting enzyme produced from a fungus grown on cattle feedlot waste had improved the feed efficiency of chicks. It is reasonable to anticipate that much more will be heard of this development in the future.

V.

MACROBIOLOGICAL PROCESSES

The quantity of manure which will be recycled in the foreseeable future by being employed as a planned constituent of the feed of animals, birds, fish, insects, or worms is probably quite small. That which will be deliberately released to ponds to become nutrients for water hyacinth, algae, yeast, or other vegetation will doubtless be even less. Use as fertilizer in which the manure, decomposed by the microlife of the soil, is recycled as crops or weeds may be expected to continue to be the major employment of manure. In the longer run, however, particularly if the trend toward concentrated production of animals -- and manure -- in a suburban environment intensifies, the recycling of manure as a feed component, its catabolism, and its botanical conversion hold much promise.

REFEEDING OF MANURE

One's initial reaction to the concepts of refeeding manure to animals or of employing it as a medium for the deliberate production of fly larvae is apt to be revulsion. Visions of pestilential epidemics are readily conjured. There are, in fact, certain dangers. Precautions to be taken are referred to throughout the literature.

DIETARY AND GROWTH FACTORS

One may easily appreciate that some nutritional value may remain in particles of feed which have been passed through a first digestive tract unutilized and essentially unaltered. There are, moreover, other values. A spate of papers in the 1940's reported the existence of "an unidentified growth factor," riboflavin (vitamin B_2), and/or vitamin B_{12} in the feces of poultry and animals. LAMOREUX and SCHUMACHER [1940-1002] established that more riboflavin was present in poultry feces than in poultry feed, with the increase occurring after defecation. KENNARD et al [1948-1003] found the riboflavin in freshly-voided chicken feces to be essentially that of the feed, but observed a build-up at room temperature of 100 percent in 24 hours and 300 percent in a week. Floor litter may thus serve as a potent source of supplementary vitamins for chickens.

HAMMOND [1942-1002] observed that a cow's rumen content was higher in vitamins than was her feed. Still greater concentration of vitamins occurred in the feces. Cow manure was found to have a beneficial effect when fed to riboflavin-deficient chicks and to cause no harm when fed to others. Later [1944-1002], in recommending

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the inclusion of cow manure in wartime poultry diets, he advised supplementing the diet with vitamin A and riboflavin.

RUBIN and BIRD [1946-1004, 1947-1002] determined that the growth factor present in cow manure is transmitted by hens in their eggs in a quantity sufficient to permit their chicks to grow well on a basal diet. RUBIN et al [1946-1005] reported 25 percent greater weight at six weeks for chicks with a five percent supplement of cow manure or urine-free hen feces in their diet. ELAM et al [1954-1001] reported increased chick growth resulting from the inclusion of a filtered suspension of autoclaved old poultry litter in the ration. Litter contributes far more to the growth of chicks than can be accounted for by its protein content alone.

BIRD et al [1948-1001] reported that young turkeys have a critical need for a growth factor found in cow manure, fish meal, or meat meal. BOHSTEDT et al [1943-1002] had observed earlier that cow manure supplies B-complex vitamins to pigs.

BIRD et al [1946-1002] established that increased hatchability of eggs resulted when a soybean meal diet was supplemented by cattle manure. GROSCHKE et al [1947-1001] observed that the addition of cow manure to a corn-soybean oil diet for chickens increased hatchability and removed its seasonal fluctuation, this latter being credited [1948-1002] to coprophagy inasmuch as dietary factors are more easily synthesized in hen feces in warm weather. KENNARD et al [1954-1003] determined that hatchability and chicken health were both far better when chickens were raised on old litter than on new, the difference again being credited to the benefits of coprophagy.

Vitamin content of manure has been shown to vary with its age and treatment. RUBIN and BIRD [1947-1003] observed that sun-dried or oven-dried cow manures were essentially equivalent, but that pasture-dried chips were inferior in poultry diets.

COPROPHAGY

Later, studies with rats by BARNES et al [1959-1001, 1963-1002] and DAFT et al [1963-1003] established that coprophagy was essential to their development. Nine micronutrients supplied to rats from their own feces were listed. Rabbits were reported by EDEN [1940-1001] to consume from 54 to 82 percent of their total fecal production. SOUTHERN [1940-1003] suggested that this trait might well account for the ability of wild rabbits to subsist during several days of cold or danger without other nurishment. DURHAM et al [1966-1025] reported on coprophagy in ruminants on all-concentrate diets, observing that in extreme cases postmortem examinations had found the reticulum and abomasum compacted with heavy deposits of soil and feces.

ANIMAL MANURE IN POULTRY RATIONS

In addition to the papers already cited, one by RILEY and HAMMOND [1942-1003] observed that the development of testes and ovaries in chicks was retarded when dried cow feces were included in the diet, but that their development was unaffected when the chicks were fed feces from mature bulls. WHITSON et al [1946-1006] reported that cow manure dried at 80°C is preferable to that dried at 45°C since the latter impairs egg production while the former does not. Hatchability was good on either ration component. TURNER [1947-1004] observed that the performance of cockerels fed manure from lactating cows fell off when the manure exceeded 10 percent of the ration, while pullets responded well to 2.5, 5, 10, or 20 percent. PALAFOX and ROSENBERG [1951-1002, 1952-1003] found that 5 or 10 percent of either oven-dried (below 158°F) or sun-dried cow manure, when substituted for mash, satisfactorily supported egg production, egg weight, body weight, hatchability, and feed consumption. At 15 percent, unresolved conflicting results are reported.

HAMMOND [1944-1001] fed cow manure (fresh, and dried and 47°C, 80°C, and 120°C) to poults as ten percent of their diet as a substitute for alfalfa leaf meal on an essentially adequate ration. Livability, growth rate, and efficiency of feed utilization were unimpaired. He considered drying at the highest temperatures to be preferable since bacteria are destroyed without impairing nutritional values. SLINGER et al [1949-1003] reported a supplement of five percent dried cow manure to be effective when fed to turkeys in a soybean-oil meal ration.

LIPSTEIN and BORNSTEIN [1971-1154] reported that dried cow manure had no toxic effect when fed to chicks, but concluded that it was a poor substitution even for inert pulverized rock. It may be significant that they reported a 36.4 percent ash content in their dried manure.

ANTHONY'S STUDIES IN RECYCLING CATTLE MANURE

The "pork value" of cattle manure -- the nutritional value salvaged on the old-time farm by the pigs which followed the cattle -- has become a casualty of modern agri-business. One is tempted to suggest that when an elderly environmentalist fondly recalls the pristine succulence of grandma's roast, the ingredient he misses may well be cattle feces. In fact, however, taste tests are rarely accurate in diagnosing this component of a pig's bill of fare.

In the only menu abstracted [1972-1009], the pièce of résistance was a Delmonico steak from a yearling steer fed an ensiled mixture containing corn (48 percent), hay (12 percent), and waste (40 percent). The menu, appropriately entitled "A Phase of Research in Livestock

Feeding," was that of a banquet served at Auburn University, site of Brady ANTHONY's amazing string of successes in feeding cattle manure to cattle.

The earliest of ANTHONY's papers which has come to the compiler's attention [ANTHONY and NIX, 1962-1001] describes a feeding trial in which a mixture of forty percent washed cattle feces and sixty percent basal feed, to which one lb of yeast per 100 lb of mixture had been added, was fed to three cattle for 54 days. Gains of 3.39 lb/day on 6.43 lb of feed (dry basis) per lb of gain were reported. ANTHONY has subsequently modified the formula several times, but the insistence on the use of fresh manure from a concrete lot, with fermentation, and with controlled handling and storage of the resulting mixture has been retained. The exclusion of mud and the preservation of freshness appear to be cornerstones of successful refeeding. Two notes in the Farm Journal [1963-1010 and 1015] and one in Compost Science [1964-1024] reported ANTHONY's findings, stressing the $8000 cost of a "washing machine" to handle a 2000-steer operation.

Reporting on his experimentation of the next several years, ANTHONY [1966-1005] observed that either washing or heat treatment was desirable; an attempt to use fresh, unwashed manure separated by screening had produced poor weight gains and been reflected in lower carcass grades. Later, trials with an ensiled mixture of 57 parts manure and 43 parts coastal bermuda grass blended with ground shelled corn and a supplement had given excellent results.

When "wastelage" (a name assigned to the ensiled mixture of 57 percent manure from full-fed slaughter cattle and 43 percent ground hay) was employed as 40 percent of the ration, gains were better than those posted by a control group of cattle fed corn silage [1968-1003, 1969-1002, 1972-1217]. In describing his experimental program at the Cornell Conference on Animal Waste Management [1969-1003], ANTHONY emphasized the sanitary disposal of organic wastes and the improved feed efficiency obtained.

BANDEL and ANTHONY [1969-1005] reported that a ratio of wastelage to whole corn of 2:3 is nearly optimum for slaughter cattle. CIORDA and ANTHONY [1969-1020] observed that even with nematode eggs present in the feces, no larvae were found in any sample of wastelage examined. ANTHONY [1970-1003] reported that "rations containing wet cattle manure were readily consumed by fattening steers and these rations supported gain essentially equal to comparable cattle fed feeds without manure. Cooking or washing manure before mixing it with concentrate for feeding did not improve its feeding value. Carcass data were similar for manure-fed and other cattle." MOORE and ANTHONY [1970-1070] reported an increase in crude protein level of wastelage from 16.99 percent to 43.26 percent by adjusting the pH level with ammonia on three successive days. The amino acids were increased by over 20 percent.

Three more wastelage tests were reported [1971-1014] and a flow sheet for the recycling of manure from concentrate-plus-wastelage-fed confined cattle was presented indicating that the disposition of the feedlot manure would be complete if the surplus wastelage were used as a complete ration for beef brood cows. ANTHONY's well-documented summary of the state of the art of animal refeeding [1971-1013] should be read in its entirety. An extract from it will be quoted in the summary of this chapter.

Currently ANTHONY is focusing his attention on lactic acid fermentation in the ensiling process [1972-C003] and on the optimum choice of material (silage, green chopped forage, cottonseed hulls, peanut hulls, rice hulls, almond hulls, etc.) for blending with the manure [1973-1001]. All hull mixtures were found to be less satisfactory than mixtures made with silages or green chopped rye forage. "To be acceptable products should be fermentable. . . The mixtures used must ferment rapidly to produce acids (preferably lactic) and the pH must be about four. Most important: When fed, silages must retain an acid pH; if the pH shifts rapidly toward neutrality when placed in the feed trough, the product will have low nutritive value."

OTHER FEEDING OF RUMINANT FECES TO RUMINANTS

ANTHONY [1967-1001] reported that ewes on a diet consisting solely of wastelage for more than a year consumed less hay but remained in better physical condition than those fed hay with no manure. McLAREN and BRITTON [1968-1030] observed that when lambs were fed a high-energy diet with roughage consisting of ground corn cobs, wheat straw, or the undigested fiber fraction of their feces at the same level as the original roughage, the percentage of roughage digested was greater for the original corn cobs or wheat straw than for the refed fecal fiber.

L. W. SMITH et al [1969-1078, 1970-1086, 1971-1229, 1971-1230, 1971-1301] reported successful experiments in the modification of cell walls in cattle feces to improve their digestibility for subsequent refeeding to sheep. SMITH and GORDON [1971-1231] reported feeding iso-nitrogeneous rations with one part cornmeal and one, two, or three parts manure consisting of feces and peanut hull bedding to heifers. There were no significant differences in growth rate or in feed-to-gain ratios.

THOMAS et al [1970] reported that heifers fed feces from dairy cattle without bedding accepted a ten to fifty percent fecal diet readily. The dry matter digestibility was 20 percent. CALF News [1970-1117] quoted Gene ERWIN as stating that "It is entirely feasible that even a small feeder will be able to process manure on his lot for conversion into a low-cost nutritious feed."

BUCHOLTZ et al [1971-1040] stated that feces must contain more than 25 percent crude protein to compete economically with other sources of supplemental nitrogen. In their feeding tests sheep had consumed all rations readily while goats had refused to participate in any fecal recycling. McCLURE et al [1971-1167, 1329] reported decreasing digestibilities for corn-based rations for cattle, rations for sheep containing 45 percent cattle feces, and the feces from the sheep.

COOPER et al [1972-1028] reported that a ration of an ensiled mixture of whole corn plant and feces from ewes on an all-roughage diet was not highly acceptable to ewes. Additional corn and soybean meal produced a ration adequate for maintenance when the fecal fraction was held below 25 percent. JOHNSON [1972-1074, 1216] found rations consisting of cotton seed hulls and up to 40 percent dried feedlot manure palatable to sheep. The digestible organic matter content of the wastes from dirt lots was low. KLOSTERMAN and McCLURE [1972-C051] reported on a 60-day feeding test in which the weight of steers had been sustained on a diet consisting solely of ensiled feedlot manure.

TINNIMIT et al [1972-1157] reported that sheep rations containing 20 to 80 percent dehydrated feces were well accepted.

SWEETEN [1973-1035, 1042] questioned the economy of the prompt collection and of the exclusion of mud from cattle feedlot manure which would be required for the preservation of its refeeding values. These are, of course, high in the list of advantages claimed for totally-enclosed confinement feeding.

In addition to the "classical" well-documented studies, such as those of ANTHONY, there are an indeterminate number of other investigations of means of salvaging the nutrient value of manure in progress or in various stages of hibernation or death. Some of these have been referred to in the chapter on microbiological processes.

Many investigators are understandably reluctant to talk until they have obtained satisfactory results in feeding tests. Questions of possible patentable features in a process or the desire to derive a legitimate financial reward for the time and money risked in research and development also inspire a cloak of secrecy.

An interesting example of such a project, nearing the pupation stage, is that developed by Feed Recycle, Inc., of Blythe, California, its consulting engineer Frank SENIOR and his associate Dr. Ralph RIPPERE. A description of the process appeared in CALF News for January 1973 [1973-1043], and an evaluation of the economics is abstracted in [1973-1029]. SENIOR, a consulting metallurgical engineer of Phoenix, was retained by the corporation, the major stockholders of which include the owners of Mortensen's Colorado River Feedyard, Blythe, and those of the Desert Ginning Co. of Ripley, California, to perfect a process for extracting the proteins, fats, and roughage values of feedlot steer manure for refeeding. The sand, salts, and most of the moisture are removed in the process.

The pilot plant, visited on 10 May 1973, had evolved somewhat from the status described in CALF News. The molasses produced in the earlier operation had not proved to be effective as a component of the feed. On the other hand, the "instant coffee" granules resulting from the kiln-drying of the cake separated by centrifuging had given most encouraging results in feeding trials. The 8000 lb/hr input to the pilot plant had consisted of 660 lb protein, 160 lb fat, 1980 lb carbohydrates, 240 lb K and NaCl, 440 lb SiO_2, 520 lb of other insolubles, and 4000 lb of water. In a second stage 5600 lb of washwater and floc had been added. The values recovered per net ton of manure, based on 315 lb of protein at 14 ¢/lb, 80 lb of fats at 9 ¢/lb, and 0.44 tons of roughage at $10/ton, totaled $55.70. Brine with a four percent salt content had been discarded to a holding tank, sand had been removed by riffles, and 55 percent of the incoming ash had settled in an aeration tank. Costs per dry ton for a 100 ton/day plant have been calculated to be $13.50.

Financing has been assured for a production plant capable of handling 100 tons per day. The first group of test cattle were slaughtered on 15 June 1973 under the supervision of the USDA, the State of California, and attendant pathologists at California Polytechnic University at Pomona. The ten cattle in the first group included five whose ration had contained eight percent Feed Recycle nutrients and five which had been on normal feedyard ration. The ten livers were critically examined and graded. Those of all five control cattle were rejected for human consumption; only two from the Feed Recycle test group were rejected.

OXIDATION DITCH RESIDUE FROM CATTLE MANURE

The use of the oxidation ditch as a method of treating wastes for land disposal has been discussed earlier. While oxidation ditches are much more common in housing for swine than for cattle, they are used to some extent in both.

Anonymous notes [1971-1286, 1289, 1291] have described the success of Gerald FRANKL in using the residue from an oxidation ditch which tested 46.8 percent protein, dry basis, as a component of a cattle ration. The residue, designated "processed animal by-product" (PAB), does not respond well to drying or other processing and, thus, should be used at the point of origin. Cattle on 35 percent PAB gained 4.19 lb/day as contrasted with 4.02 for the controls. When slaughtered, the cattle were graded choice. Rations have been inched up to 65 percent PAB without rejection. BRIDGSON [1972-1020, 1179] reported that cattle on a 37.25 percent PAB ration consumed more feed and gained weight faster than control cattle.

VETTER et al [1972-1160, 1225] reported feeding beef oxidation ditch residue, which they designated "processed animal waste nutrients" (PAWN), in amounts as great as 6.8 kg/day per steer without observable effects on carcass grade, yield, or health.

FEEDING OF CATTLE FECES TO SWINE

Despite the historic tradition previously mentioned, few tests of the value of cattle feces in swine rations have been recorded. SQUIBB and SALAZAR [1951-1003], reporting on the feeding of sun-dried fresh cow manure subjected to a hammer mill, observed that despite the fact that pigs ate the rations readily and consumed as much feed as did pigs on Corozo palm nut meal, sesame oil meal, bananas, or animal protein factor, the lots fed cow manure were unthrifty and lacked uniformity. PUTNAM [1971-1211] reported that the Agricultural Research Service (ARS) had fed beef feedlot manure, subject to various treatments, in amounts up to 85 percent of the rations of swine successfully at Beltsville.

RECYCLING SWINE FECES

DIGGS et al [1965-1007] reported that in a 63-day trial with the rations containing 0, 15, and 30 percent dried pig feces, pigs gained 1.56, 1.71, and 1.53 lb/day respectively. Feed intakes were 3.63, 3.62, and 4.65 lb/day. No undesirable flavor was detectable.

ORR et al [1971-1193, 1194, 1317] reported that corn-soybean meal rations with as much as 22 percent dried swine feces were accepted by swine with 90 to 95 percent full appetite. The flavor of the meat was unaffected. Dried swine feces containing 21.6 percent crude protein were detrimental to daily gain and to feed-to-gain ratios because of low amino acid content. MILLER [1972-C070] reported that swine wastes were preferable to poultry wastes in swine finishing rations.

SWINE OXIDATION DITCH RESIDUE

DAY et al [1971-1066] reported that pigs on oxidation ditch residue (ODR), substituted *ad libitum* for water in the ration, showed greater weight gains and better feed efficiency. HARMON et al [1971-1120] observed that swine ODR, screened to remove hair and bran then freeze-dried, contained 41.5 percent protein. Rats showed best weight gain and greatest feed efficiencies when their ration contained zero to four percent ODR. HOLMES et al [1971-1135] found a crude protein content of 27.7 percent, dry basis, for the suspended solids in swine ODR, and concluded that it could be substituted for 10 to 20 percent of the other proteins in rats' diets.

HARMON [1972-C043] concluded that concentrations significantly higher than the two percent dry matter typical of swine ODR will be required. For an oxidation ditch in continuous operation for three years, the dry matter tested 51 percent protein, 1.4 percent lysine, 2.0 percent threonine, 0.9 percent methionine, and 40 percent ash. HARMON et al [1972-1062] reported that swine ODR had a 27.7 percent protein content and that it could replace from a third to half of the protein in casein or soybean meal for rats.

POULTRY MANURE IN ANIMAL FEEDS

Poultry manure tends to be richer in nutrients than animal manure. Moreover, layers are fed few antibiotics and thus the worrisome problems of drug and hormone residues may be minimized by the selection of caged layer manure as a feed component.

VERBEEK [1960-1005] observed that a ration containing 24 percent fowl manure with mealie cobs provided a good source of nitrogen for oxen. Other nutrients and spilled feed in the wastes added value. The manure made a good addition to roughage for tiding oxen over a winter.

Several authors have reported feeding tests in which poultry wastes replaced soybean meal or other sources of protein with essentially equivalent daily weight gains [1966-1064, 1968-1007, 1970-1096, 1972-1146, 1973-1009]. BUCHOLTZ et al [1971-1039, 1040], however, reported lower feed efficiencies on dried poultry wastes (DPW) than on soybean meal or urea, and observed that the manure should contain more than 25 percent crude protein to compete economically with other sources of supplemental nitrogen. They mentioned that steers sorted out and avoided the DPW, sheep consumed all servings readily, and goats refused the ration.

LOWMAN and KNIGHT [1970-1054] estimated the cost of the protein from DPW to be about one-third that from competing sources. In other economic studies, LOWMAN [1969-1049, 1092, 1094; 1970-1130] states that Toplan, a sterile DPW with a crude protein content of 26.6 percent available on the British market, when fed as 25 to 50 percent of a ruminant ration saves 30 percent on feed costs. BULL and REID [1971-1041] observed that air-dried poultry manure was particularly effective with corn silage since the combination eliminates dust, masks odor, and saves $12 to $15 per ton.

THOMAS et al [1972-1155] reported that economic studies indicate the desirability of using relatively large amounts of dried manure from caged layers as nitrogen and energy sources for cows and lambs. SMITH and FRIES [1973-1034] observed that, despite reduced milk output from cattle fed DPW, the economics of feeding it compare favorably with those of conventional sources of crude protein. FAIRBAIRN [1970-1135] stated that the protein value of DPW is about that of cereals, but that the energy content is only about one-third that of grain. He concluded, however, that DPW is suitable and economic as a feed component.

COUCH [1972-1030] observed that the low energy content of DPW makes it unadvisable as a component of chick feeds above five percent. The age of the manure at the time of drying and the method of drying were recognized to affect the energy content critically. Swine were reported to show depressed feed conversion with as little as five percent DPW. Sheep can obtain up to fifty percent of their total nitrogen from it without adverse effects. The best use of DPW is considered to be as cattle feed. NATZ [1972-1117] also observed that DPW has been recommended as a cattle feed.

PEREZ-ALEMAN et al [1971-1204] fed DPW as 10, 20, and 30 percent of a swine ration with no adverse effect on the pigs' health or carcass quality. They reported that DPW contained 30 percent crude protein and was rich in minerals. ORR [1971-1193] reported that DPW was of somewhat less value than dried swine feces in swine rations because it is low in critical amino acids and high in calcium.

THOMAS and ZINDEL [1971-1248, 1972-C110] reported no adverse effect on the quantity or quality of milk from dairy cows fed 30 percent DPW.

LOWMAN and KNIGHT [1970-1054] observed that, whereas barley contains 48 ppm Cu and DPW contains 73, the copper available to sheep fed barley or DPW was 24.5 and 17.6 ppm respectively. SMITH et al [1973-1033] observed that "withdrawal of arsenic from feed resulted in a rapid decrease in tissue arsenic concentration."

POULTRY MANURE IN POULTRY FEED

The benefits which poultry derive from the reingestion of their feces in terms of growth, increased hatchability, and general well-being have been discussed. Additional studies in a similar vein include those of PRYOR and CONNOR [1964-1015] who reported that 30 percent of the original metabolizable energy present in a high-energy chicken ration was available for reuse. FLEGAL and ZINDEL [1970-1022, 1023, 1024; 1971-1090], in studies directed toward compensating for the low energy content of DPW, found that the addition of stabilized fat improved performance of layers on a diet which included 20 percent DPW. The egg-laying efficiency was unaffected to 20 percent DPW; the taste difference of the eggs was undetectable to 30 percent; and the egg quality was unaffected at 40 percent. Feed efficiency declined with increasing proportions of DPW in the ration.

BIELY et al [1972-1018, 1973-1050], reporting on feeding tests of well-balanced isonitrogenous isocaloric rations containing 5 to 30 percent DPW, found no detrimental effects on the health of the birds. Growth and feed efficiency decreased above 10 percent. BERGDOLL [1972-1014] suggested that the optimum refeeding level for laying hens is in the range of 10 to 15 percent DPW, with the manure replacing an equal amount of corn.

The feeding value of manure, it must be remembered, is subject to rapid deterioration with improper storage or mishandling. MILLER [1971-1173] observed that poultry manure catabolized by fly larvae had little value as chick feed.

HODGETTS [1971-1133] reported that a flock of British chickens showed improved performance on a 10 percent DPW diet. Savings resulting from the refeeding were 44 cents per bird. ZINDEL and FLEGAL [1971-1275] evaluated DPW as a replacement for 25 percent of the corn in a layer ration at $10 per ton. For comparison, they calculated the gross value of wet manure as a fertilizer to be $2.39 per ton; the cost of spreading it would be $11.96.

LaSALLE and LAUNDER [1969-1042] reported on a proposal of the Hupsi Corporation to catch chicken droppings in troughs of weak phosphoric acid, then salvage the protein and other values for refeeding. By refrigerating the acid during the cycle, air conditioning could be provided in the hen house.

A fascinating study, designed to provide a definitive answer to some of the haunting questions of possible cumulative effects of refeeding, is being conducted at Michigan State University. ZINDEL [1972-1170, 1204] reported that after 35 cycles in which DPW was refed as 12.5 or 25 percent of the hens' ration, no build-up of heavy metals had occurred. He concluded that these percentages could be recycled with safety. FLEGAL et al [1972-1045, 1190], reporting after 31 cycles, observed that the chickens on 12.5 DPW were outperforming those fed 0 or 25 percent. FLEGAL [1972-C032] also reported that performance on recycling was as good with 10 or 20 percent DPW as with none. Performance was poorer at 30 percent, and egg production was off 40 percent at 40 percent DPW. Interim reports by various investigators have been abstracted [1971-1089; 1972-1159, 1208, C110; and 1973-1052].

LANGSTON [1971-1318] reported on a 36-hour process of heating to kill pathogens followed by fermentation and refeeding of the manure to the same chickens. No ill effects were observed. CLIZER [1972-1006] has emphasized the establishment of proper controls for attaining uniformity of product. He and BARTON [1972-C005] both stressed research to secure compliance with FDA requirements.

Lest the reader gain the impression that poultry manure recycling is a complete solution to ultimate disposal, he should heed the sobering comment of OUSTERHOUT and PRESSER [1971-1200] that "recycling manure reduces the disposal problem by no more than 25 percent with no noticeable further reduction with further recycling." NESHEIM [1972-1118] added that while acceptability of manure is good, chickens compensate for its low energy content by eating more and, thus, producing more manure.

POULTRY LITTER IN ANIMAL FEED

Poultry manure has been described through the use of many adjectives. All of them have repulsive connotations of sliminess, stickiness, and stench. By comparison, poultry litter is relatively unobjectionable. The litter base of sawdust, wood shavings, crop residues, or other organic dry matter soaks up considerable moisture and, with competent management, may be refed without drying. Heating for sterilization is often practiced, however. Since roughage is a major component of ruminants' diets, its inclusion earlier as a litter base may be advantageous.

NOLAND et al [1955-1001] reported that ewes fed ground chicken litter did as well as those fed soybean meal and better than those fed ammoniated molasses as a source of nitrogen. Steers fattening on chicken litter did nearly as well as those on cottonseed meal when the total feed intake on litter exceeded that on cottonseed meal by 15 percent. CAMP [1956-1003, 1959-1003] included 40 percent litter based on peanut hulls or cane pulp in a formula proposed for cattle. He quoted the protein content of once-used litter as 21 or 22 percent, and of litter after nine uses as 33 percent. He advised potential users to avoid rocks, nails, and glass.

CARMODY [1964-1005] recommended a formula based on 1500 lb litter, 500 lb energy feed, 10 lb dicalcium phosphate, vitamins A and D, and salt. On free choice, cattle ate 25 to 28 lb of litter mix and 5 to 6 lb of hay per day. The litter mix was unpalatable when wet.

LEWINGTON [1964-1010] proposed a mix of 1800 lb litter, 200 lb corn hominy, minerals, vitamins, and hay for cattle. For sheep he advised a formula of 1600 lb litter and 400 lb of broken white bean mix. He cautioned that sterilization of the litter would destroy its feed value.

DRAKE et al [1965-1008] reported that feed efficiency was higher with 25 percent peanut hull litter than with 25 percent wood shaving litter. Both were preferable to a zero-litter control. However, a 25 percent litter diet was preferable to one of 40 percent. BHATTACHARYA and FONTENOT [1965-1003] determined that the optimum litter fraction for ruminants was that for which the nitrogen from poultry litter was about half of the total nitrogen intake. Several authors [1958-1003; 1966-1003, 1012; 1968-1020] have suggested the use of dried citrus pulp, beet pulp, corncobs, etc., as being more nutritious than wood or hulls in feeds.

SOUTHWELL et al [1958-1003] advised the running of a chemical test on each batch of litter before using it because of variability. BRADLEY and RUSSELL [1965-1004], observing that litter was highly variable, advised adding vitamin A, and suggested that molasses might help palatability. They advised against the use of dusty litter, as had RAY [1959-1008].

BRUGMAN et al [1964-1004] reported that litter is high in protein but is low in energy, vitamins A and D, and phosphorus. BHATTACHARYA and FONTENOT [1964-1003, 1966-1009] observed that litter compares favorably with alfalfa hay in sheep rations, but that the percentage utilization of absorbed nitrogen from an autoclaved peanut-hull litter tended to decrease with increasing levels of the litter nitrogen. FONTENOT et al [1966-1029] reported that litter samples contained 32 percent crude protein on a dry basis. The average digestion coefficient of the crude protein was 72.5 percent. McANDREWS and KERR [1966-1048] observed that poultry litter supplies protein from undigested poultry feed and from bacteria.

BRUGMAN et al [1969-1014] found no significant differences in feed efficiency of sheep fed six different rations calculated to have a crude protein content near 17 percent. Costs ranged from 4.5 ¢ to 7.1 ¢ per kg. DAVIS [1956-1001] had reported earlier that feeding costs had been cut as much as 60 percent by feeding poultry litter to cattle and hogs. Drugs in the litter had been responsible for some stillbirths.

The controversy over the merits (pathogen reduction) and demerits (reduced nutritive value) of sterilization of poultry litter has been mentioned. Additional discussion may be found in several papers [1967-1004; 1968-1002; 1970-1031; 1971-1094, 1095, 1123, and 1171]. CASWELL et al [1973-1006] recently described several methods of sterilization, none of which was found to have a significant effect on apparent digestibility or nitrogen utilization.

CREAGER et al [1973-1008] reported the elimination of pathogens from broiler litter on pine shavings by ensiling. No drug carry-over of any consequence was found in their investigation.

OMOHUNDRO [1966-1057] reported that the USDA had advised against the refeeding of litter because of variability in nutritive value, undetermined effect of drugs in the poultry feed, and the possibility of disease transmission. KIRK [1967-1008, 1028] announced that the FDA does not sanction the use of poultry litter for animal feed. BRUGMAN et al [1968-1008, 1972-C014] reported the finding of drug residues and arsenic in litter-fed lambs, but of failing to find either in the carcasses. CARRIÈRE et al [1968-1010] reported that mycobacteria may survive at least a month in poultry litter. In heated litter, competitors may be killed and mycobacteria may survive two months longer. GRIEL et al [1969-1030] attributed abortions which occurred in a herd of cattle which had grazed on pastures heavily fertilized with dried poultry litter to estrogens present in the chicken feed. WEBB et al [1973-1039], reporting on tests through two lambing cycles of sheep fed 0, 25, and 50 percent broiler litter, mentioned possible copper toxicity as the only problem encountered.

FEEDING LITTER TO POULTRY

Few references were found to the feeding of litter to poultry. WEHUNT et al [1960-1006] recommended that hydrolyzed broiler litter be added to chick diets suboptimal in protein. CHALOUPKA et al [1968-1011] observed that chickens raised on reused litter are less apt to be condemned for Marek's disease than are those raised on fresh litter. QUISENBERRY and BRADLEY [1969-1070] reported that the performance of laying hens on isocaloric isonitrogenous diets containing 10 and 20 percent of untreated litter and droppings was generally better than that of the controls.

GERRY [1972-C035] found that bird weight and percentage of egg production decreased with increasing percentage of litter in the feed.

WORM MANURE

Without second thought, one jumps to the conclusion that meat and eggs are primary products and that manure is a by-product of low or negative value. Such may not always be the case. HANCOCK [1956-1002] reported on the raising of worms on a ration of peat moss, commercial laying mash, corn meal, and a small amount of molasses to harvest the compost produced by their excrement. Broilers raised on the compost reached 3-1/2 lb weight in 8 weeks. The other half of the same flock, raised on regular commercial broiler feed, required 10 weeks to reach 3 lb.

IMPROVEMENTS IN THE FEEDING VALUE OF MANURE

L. W. SMITH et al [1970-1086] have been investigating treatments of fecal cell walls to enhance the digestibility of the cellulose and hemicellulose residues present. HAMILTON et al [1971-1118] believe that fermentation may provide a means of improving the quality of manure as a feed. SAYLOR and LONG [1972-1136] tested ensilages of corn field residue or oat straw with poultry manure or cow manure. The poultry manure yielded higher protein values than the cow manure, and both were higher than the control which contained no manure. ANTHONY, as previously cited, has been feeding ensiled "wastelage" for years with outstanding success. WALKER and GRAHAM [1972-C103] are investigating pressure cooking.

McQUITTY and BARBER [1972-1107] cite a Dutch patent [their entry A-549] for a process of hydrolyzing animal wastes to polypeptides with H_3PO_4 at pH values of one to three followed by partial evaporation of the water. After $CaCO_3$ has been added to bring the pH to five to eight, a loose granular meal results. They also cite a 1970 South African patent [A-632] for treating waste with NH_3 at proper temperature and pH, digesting it with mineral acid, then treating the result with inorganic nutrients to obtain modified polysaccharides. These may be fed to animals permitting them to receive in available nontoxic forms, dosages of inorganic nutrients normally toxic.

HERRICK [1972-1068] has concluded that manure from beef cattle on high grain rations is best for recycling. While poultry litter gave fair results, he did not recommend its use because of concern over costs, pathogens, drugs, hormones, and antibiotics. PRICE [1972-1127] observed that DPW may be more valuable for ruminants than for poultry since only ruminants can convert urea to uric acid and thus utilize its nitrogen content.

ATTITUDES

FOERSTER [1966-1028] commented that the renderer has equipment to convert wastes sufficiently to "circumvent the stigmas, reservations, and variability inherent in a direct manure product." KING [1970-1043] observed that research on refeeding has been slowed by the checks and restraints of regulatory agencies and the uncertainty of consumer reaction. HERRICK [1971-1130, 1131] maintains that costs will usually exceed nutritive values, and that drugs, hormones, and antibiotics leave unanswered questions.

TAYLOR [1971-1245, 1246, 1293] stated that the basis of the current FDA ban on refeeding of litter is that the agency must be assured of the safety to man and animals. Specifically, it will require information on the source of the raw material, a stepwise description of the processing, and a description of the end product and its intended use. KIESNER [1972-1078] observed that arsenicals are routinely fed to chickens but not to man or cattle. Copper fed to chickens has reportedly caused trouble in cattle. GOLUEKE [1972-1054] noted that the use of organic wastes in animal feedstuffs holds great promise provided pathogen transmission is explored, toxic content is investigated, and FDA approval is secured.

ALAMPI [1971-1005] demanded approval of the reuse of manure. KIESNER [1971-1144] urged research to satisfy the FDA, and public relations procedures to reassure the public. KOTTMAN and GEYER [1971-1146] predict that refeeding will be common long before the year 2000. ZINDEL [1971-1273, 1310, 1317] tabulated results of feeding DPW to chickens, sheep, and cattle, then suggested that the FDA should be realistic. He feels that state supervision would be preferable. GRAHAM [1972-1056] suggested that the current emphasis on ecology might be used to promote acceptance of refeeding. VAN HOUWELING [1972-1191, 1210] suggested that current research at Michigan State University and Virginia Polytechnic Institute could lead to an easing of the FDA ban.

A BRITISH VIEW

The refeeding of manure is prohibited in the United States and in the nations within the European Economic Community. It is permitted in the United Kingdom and Canada. BLAIR and KNIGHT [1973-1003] described British practice in a recent article in Feedstuffs. Only dried poultry manure is used commercially at present. The authors state that "the most important requirement is to reduce a wet, sometimes semi-liquid material to, at the very most, 15% moisture. This moisture level is sufficiently low for milling and manufacture but the manure may not store for long periods. If the moisture content is reduced below 10%, the dry manure will store for at least one year, and probably much longer." Grinding is employed to remove lumps which "do not dry out and could harbor bacteria. Also poultry manure contains a high number of feathers and other manures may contain wood shavings. . ."

With an all-round high standard of cleanliness and hygiene practiced on the farm and at the dryer, coupled with regular microbiological and chemical analyses, the authors contend that "in the present state of knowledge dried poultry manure that has been properly processed appears to present no serious health dangers when fed to ruminants. . . The use of litter should be considered with care."

They conclude by observing that "in the U. K., dried poultry manure has been used commercially as a feedstuff for several years. No cases of failure due either to contamination with microorganisms or feed additives have been reported." However, "very few additives are now fed to laying stock in the U. K."

UTILIZATION OF MANURE BY FISH

Though there are few places in the world that have trouble with the problem, water can be too pure to support fish life. The much more frequently observed phenomenon is that it can be too contaminated for their survival.

Between the extremes, a fairly wide band of nutrient concentrations in water exists within which the degradative processes have an oxygen demand moderate enough to leave adequate supplies of both oxygen and nutrients for fish. By controlling the rate of inflow of nutrients -- and the nutrients may well be manure -- near optimum conditions should prevail for fish culture. Such a plan was proposed at the 1964 winter meeting of the American Society of Agricultural Engineers as reported by HART et al [1965-1010].

Experimentation with catfish was conducted by DURHAM et al [1966-1025] who stocked six ponds 100 ft long, 10 ft wide, and 4 ft deep at three levels of stocking: 100 fish per pond (4300 per acre), 300 per pond (12,900 per acre), and 550 per pond (23,650 per acre). The fish in one group of ponds were fed a ration of cottonseed cake (41 percent protein) and milo. The others received a 50-50 mixture of the cotton seed cake and feedlot manure. Total daily ration was approximately seven percent of body weight.

"Although efficiency of gain was greatest in the ponds stocked with the fewest fish, total gain was greatest in the heavily stocked ponds. . . Ponds stocked at the rate of 23,650 fish produced a net gain of 3750 lb per acre. . . There was no significant difference between the total gain by the two feeds."

YECK and SCHLEUSNER [1971-1272], in an excellent survey of the many means of recycling animal wastes, pointed out that the major constraint on fish culture as a means of manure disposal is the tremendous area which would be required to accomodate the relatively light manure loadings permissible.

MULKEY [1972-1113], in discussing the pollution problem associated with intensive fish farming, observed that the wastes from catfish production (which include fecal material, metabolic waste products, and uneaten feed) are a potent source of slug-flow contamination when the ponds are cleaned out after the harvesting of each fish crop. It would appear that the deliberate introduction of manure into the operation should be approached most cautiously.

The progress reports on an investigation of the feasibility of using livestock manure as a feed ration for bullheads and carp being undertaken by CROSS [1972-C021] are hardly encouraging. "At the end of four weeks, two fish [of 14] had died and the remaining individuals had lost between zero to three grams weight instead of gaining. Test was discontinued. . . We hope to continue next spring when fish are available."

THE FLY: PEST OR PROTEIN?

A number of the papers abstracted for this report treated, at least incidentally, the problems created by flies. Whenever a process rendered manure less inviting to flies, this characteristic was listed among its advantages. ANDERSON [1966-1004], appeared at first glance to dissent by observing that an advantage of a manure pile is that it attracts flies from a large area to lay their eggs. However, he went on to recommend removal and rapid drying at five- to seven-day intervals to destroy the eggs.

FLY CONTROL

Quite a number of papers [1959-1002; 1961-1001, 1002, 1004, 1005; 1963-1004; 1970-1063, 1064, 1065, 1066; 1972-C046, C087] treat the potential of including insecticides in an animal's feed to render the manure lethal to flies. Others suggest the utilization of their many natural predators. ANDERSON's [1964-1002] list of some of these includes parasitic wasps, earwigs, beetles, and mites which feed on fly eggs and/or larvae; spiders and birds which feed on larvae and/or adults; and fungi which kill many flies. The larvae of the black garbage fly, *Ophyra leucostoma*, attack and feed on other fly larvae whenever the latter are present. "When contained with a superfluous number of prey they always killed many more per day than they could possibly eat. The beneficial result of this behavior is that the superfluous prey larvae killed by *Ophyra* are eaten by the remaining living prey species." He observed [1965-1002] that insecticides and flames may be harder on the predators, which often tend to remain near exposed surfaces, than on the fly larvae which may burrow more deeply into the manure. Manure removal may be detrimental. "New accumulations of fresh wet droppings were considerably more conducive to housefly propagation than to repopulation by mites."

HARTMAN [1970-1033, 1971-1124] emphasized that beetles and their larvae (mealworms) eat fly eggs and larvae. The beetles keep the manure mass aerated, and thus less odiferous, in seeking their prey. PRICE [1970-1079] and DANKO [1971-1296] also had words of praise for the efficacy of beetles.

AXTELL [1972-C004] developed an integrated program of fly control in the poultry-producing industry based on biological control, manure management, and a minimum use of insecticides. His publications in J. Econ. Entomol. 63: 400-405, 1734-1737, 1786-1787 (1970) came to the writers' attention too late for inclusion in the bibliography.

ANDERSON [1972-C002] has issued progress reports on an investigation, begun in 1964, of the integrated control of flies and the role of dung-inhabiting insects in natural recycling of dung. Some predators which "feed voraciously on house fly larvae under laboratory conditions" have been discovered.

RODRIGUEZ and RIEHL [1959-1009, 1962-1009] reported that a cockerel with access to the droppings under ten confined hens ate all the fly larvae. The cockerel was fed at dusk to assure a good appetite during hunting hours. They cautioned that the manure should be kept as dry as possible and that spillage of feed should be avoided. A 15-week old cockerel will consume about 200 grams of flies per day. This exceeds his free-choice consumption of grain or mash. LaBRECQUE and SMITH [1960-1003] reported similar performance and stressed, as had RODRIGUEZ and RIEHL, that the cockerels remained healthy.

GOJMERAC [1972-1213] reported that 250 cockerels, housed in a yard at the University of Wisconsin to which the daily manure production is brought, are "doing a good job of fly control."

FLY UTILIZATION

ANDERSON [1966-1004] observed that fly larvae degrade manure effectively and could provide protein for chickens, animals, or humans. CALVERT et al [1969-1017, 1018] described laboratory preparation of dried fly pupae which contained 63.1 percent protein and 15.5 percent fat, both of good quality. They established that the protein from fly pupae is equivalent to that from soybean meal in chick diets. The manure converted by the pupae was essentially odorless and had a loose, crumbly texture.

MILLER [1969-1056, 1970-1136] established a breeder stock of disease-free houseflies and developed a procedure for collecting their eggs and distributing them at an optimum concentration on fresh manure. He reported that either pupae or adult flies killed by heat would provide a protein-rich feedstuff. The manure would have become stabilized with a reduction in moisture content of 50 to 75 percent. He and SHAW [1969-1058] suggested an alternative method of harvesting which involves spreading the manure, containing fully-developed pupae, in a thin layer on a screen under an intense light. In avoiding the light, the pupae crawl through the screen. Harry EBY, at Beltsville, has modified the process and built a machine capable of handling manure in ton lots. Edwin KING, of Clemson, has added a refinement consisting of a chute and funnel whereby the larvae who escape the light wind up in deep freeze.

TEOTIA and MILLER [1970-1094, 1095] determined that the optimum conditions for fly larvae are at a temperature of 25°C and a relative humidity of 38 percent. They will abandon the manure if the moisture content reaches 80 percent and are subject to fungal attack at a temperature of 37°C and a relative humidity of 70 percent. MILLER [1971-1172] concluded that the optimum pupal crop has a weight of about two percent that of the fresh manure. A 69-page report [1971-1173], rich in tables and charts and well-documented, summarizes MILLER's findings through 1970.

Studies at Beltsville by CALVERT, EBY, MORGAN and MARTIN, in addition to those already cited, [1970-1012, 1072; 1971-1049; 1972-C017; 1973-1024] have indicated that the excreta from 100,000 hens could produce 500 to 1000 lb of pupae per day. Alternatively stated, fly larvae can convert 100 lb of manure from cattle or poultry into 2.5 to 3 lb of good protein feed supplement (the larvae) and 50 to 60 lb of semi-dry practically odorless soil conditioner. For efficient operation, the humidity of the manure should be controlled and any flies which hatch should be confined.

BEARD et al [1972-C007] are conducting similar experiments on houseflies and various species of glowflies.

HODGETTS [1972-1069], in a survey of American practice written for a British publication, devotes much attention to the potentials of fly culture.

BEETLES AND EARTHWORMS

ANDERSON's observations on the appetites of certain beetles for fly larvae have been cited. He also noted [1966-1004, 1971-1009] that some species of African dung beetles have established phenomenal performance records for the disposal of elephant and other manure. He has identified 50 species of flies and 35 of beetles in the cowpats in California pastures. Of these, only the horn fly and face fly are pests; the others speed the recycling of the manure. Only seven species of flies appear to have adapted to life in the feedlot where manure is churned underfoot.

FINCHER et al [1970-1020] praised the service rendered by beetles in preserving the nitrogen values of manure by burying it promptly. They reported that in Australia, where no native bovine or ovine species existed, cattle dung remained on the ground for years having an effect somewhat like that of a noxious weed "because cattle will not graze on the rank growth around these dung pads." SANCHEZ [1973-1028] reported enthusiastically on the abilities of Afro-Asian dung beetles, imported to Texas from strains acclimatized to Australia, to control manure-breeding flies that affect cattle. Being nocturnal, these beetles are less subject to elimination by predators and are thus less apt to serve as intermediate hosts for parasites of the predators.

FOSGATE and BABB [1972-1046] reported that a diet of raw dairy cattle feces and water with sufficient lime added to maintain a pH of 7.0, would produce a kg of earthworms for each two kg of dry manure. The earthworm castings constitute an excellent greenhouse potting soil. Earthworm meal, containing 58 percent protein and 2.8 percent fat, is very palatable to domestic cats.

ALGAE

Algae have posed an enticing salvage problem wherever the combination of water rich in nutrients and adequate sunlight has occurred. OSWALD [1962-1008] observed that algae production at Richmond, California, can average 30 tons per acre per year, ranging from a rate of five tons in December to 60 in July. This, he observed, is two to ten times the peak yield of commercial crops. For protein production he quoted the following figures: algae 12 tons/acre-year; soybeans, the best vegetative crop, 1 ton/acre-year; and farm animals 100 to 200 lb/acre-year.

COMBS [1952-1002] reported that the substitution of chlorella, a common species of algae, for an equal amount of soybean meal as ten percent of the basal ration for chicks increased growth and feed efficiency but led to beak deformities. GRAU and KLEIN [1957-1001] stated that the chick can tolerate diets containing up to 20 percent aluminum-free algae meal. In obtaining this, alum-floculation harvesting procedures must be avoided. ZANEVELD [1959-1010] surveyed the marine algae of south and east Asia in a text keyed to 161 references. The uses to which the algae were being put were usually as human food.

Effective algal activity in waste purification, as WURTZ [1962-1071] observed in a paper presented at a symposium on ALGAE AND MAN, depends on having the correct species present in a polluting environment tolerable to them.

HART and GOLUEKE [1964-1013, 1965-1009], in an economic evaluation of the production of algae in a manure lagoon, quoted the figures of 1.3 ¢/lb of dried algae for concentration, 1 ¢ for dewatering, and 1.5 to 2 ¢ for final drying. They concluded that algae was an uneconomical feed for livestock at the time. DUGAN, GOLUEKE, and OSWALD [1968-1014; 1971-1199; 1972-1035, 1122], continuing the studies at Richmond, have operated an essentially closed-cycle process in which the wastes from a hen house were fermented in an anaerobic digestion tank with the effluent draining directly into an algae pond. Water from the pond was used in flushing the hen house and the algae were fed to the chickens. The pond was aerated mechanically during the winter. Algae production was 30 to 40 tons (dry basis) per acre of pond surface. Costs of about 2 ¢ per dozen eggs produced would be incurred in either an algal or mechanical aeration operation. The value of the nitrogen recovered from the algae "could be as much as 3 ¢ per dozen eggs where sunlight is adequate and land inexpensive."

HINTZ et al [1966-1035] reported that algae have high crude protein and other food values but contain considerable ash and present some palatability problems for swine, cattle, and sheep. They suggested pelletizing the algae with other feed to mask the flavor. OSWALD has observed that different species of algae have quite different tastes -- and the aromas of jars of powdered dried algae in his office would corroborate this emphatically. Chickens, it seems, have a poor sense of smell.

Several other investigations [1971-1215; 1972-1200, C049] into various aspects of algal harvesting have been initiated or proposed recently.

HYDROPONICS

DYMOND [1949-1001], in an appendix to VAN VUREN's classical text, "Soil Fertility and Sewage," lauded the role of water hyacinth as a trapper of salt and a purifier of water. He quoted production figures of 1100 tons per acre (66 tons of dry matter) and suggested that the plants be harvested and composted.

BOYD [1969-1011] observed that water hyacinths, water lettuce, and hydrilla have mean crude protein levels as high as those of many high quality forages. They should be dehydrated before being fed, and should be harvested at the proper stage since the composition changes as the plants age. Later [1970-1009], he added that water hyacinth is an effective remover of nutrients and that the harvesting cost may be offset by its feeding value. Economics dictate sun drying before dehydration. Mosquitoes constitute a problem in that the use of pesticides is restricted on feedstuffs.

MINER et al [1971-1119, 1180; 1972-1181] grew water hyacinths in dilute effluent from an anaerobic swine lagoon in Iowa. The evapotranspiration was 3.2 to 3.7 times that from an open water surface. They produced 84 tons per acre (5 tons per acre, dry basis), removing 500 pounds of nitrogen per acre in the process, and obtained an effluent of good quality. The plants had value as cattle roughage and Iowa winters could be depended upon to prevent undesired proliferation.

EBY [1966-1027] reported on experiments with the hydroponic growing of various grasses in greenhouses and in test plots. To be useful, such plants should deplete the nitrogen, phosphorus, and potassium in the effluent in which they are grown. They should also be nutritious to livestock and be easily harvested. He listed the advantages of hydroponic agriculture as being 1) an ability to utilize manure with a minimum of handling, 2) a potentially greater yield per acre than can be obtained with conventional agriculture, and 3) a reduction in potential pollution. LAW [1969-1043] grew tall fescue and perennial ryegrass in secondary sewage effluent in hydroponic culture tanks. The nutrient removal was slight. HENTGES et al [1972-1067] reported that yearling steers remained healthy on diets of coastal bermudagrass, water hyacinth, or Florida elodea (a plant which grows submerged). They found aquatic plants to be adequate in energy but low in useful nitrogen. STEPHENS et al [1972-1151] reported that wide differences exist in the nutritive value of coastal bermudagrass; water hyacinth, and hydrilla.

CULLEY [1972-C025], in an early progress report on experiments with duckweed in Louisiana and Arkansas, mentioned wide variations observed in crude protein values. "Spirodela oligorhiza was grown on an animal waste lagoon, treated municipal sewage waters, and untreated septic tankwater during the first three months of 1970. Protein content was 42, 31, and 30 percent respectively on a dry-weight basis. Water content of the plant averaged 95%. Improved growth rates occurred in poultry when this plant was substituted for alfalfa in chicken feed." Further reports on this continuing project will bear watching.

AN EVALUATION OF REFEEDING

When ANTHONY [1971-1013] undertook an evaluation of the practice and justification of the refeeding of processed manure to animals, he began with the following paragraph.

> "Organic waste originating from livestock in the United States far exceeds in quantity the combined organic waste output of the human population -- a frightening statistic in a pollution conscious era. In reality, however, with the exception made for special areas, animal waste is currently a nuisance rather than a calamity. By application of 20th century man's tools, his ingenuity and his willingness to act on fact rather than hearsay, he can convert this oozing mountain of animal organic waste to one of his great resources. A conditioned observation, however, is that the mountain will continue to ooze and man's effort for containment will be feeble in response to superficial reporting and philosophical prejudices. Another observation is that conventional sanitary engineering concepts developed for human waste disposal offer for animal waste a dead end street with calamitous consequence. Currently most funded research in animal waste management is designed to use experimental procedures developed for human waste disposal."

That refeeding can be done safely has been well established. Good housekeeping would be required, but such practice has monetary as well as public health rewards since the nutritive value of manure deteriorates with age and careless handling.

British experience with the refeeding of dried poultry waste seems to have been highly satisfactory. ZINDEL, FLEGAL and their co-workers at Michigan State have certainly explored the residual build-up on recycling -- and are satisfied [1971-1273] that relaxing of present prohibitions would be justified. ANTHONY's experiments with "wastelage" have demonstrated that cattle manure can be refed with safety and, at least in moderate-sized installations where brooder cows on pasture can utilize the excess production of steers on concentrate feed, with complete disposal.

L. W. SMITH [1971-1228] surveyed the literature on refeeding in a paper which was combined with four others devoted to particular aspects of fecal residues from feed additives, hormones, antibiotics, and larvicides in a publication of the Agricultural Research Service, ARS 44-224. This collection of papers with its extensive list of references should be consulted by any serious student of the subject. Two other papers by SMITH [1972-1145, 1973-1032] explore the scientific basis for refeeding rather fully.

In view of the wide range in nutritive values of manure, capital investment in housing or pens to provide a desired degree of quality control, costs of processing the manure, and costs of disposal of the excess, no attempt was made to provide an economic analysis of refeeding. For a particular situation, with appropriate assumptions of the costs of complying with modified FDA regulations, such an analysis could be prepared.

The evaluation by SENIOR [1973-1029] for Feed Recycle, Inc., is a good example of such a document.

VI.

THERMOCHEMICAL PROCESSES

COMPOSITION OF MANURE

The composition of manure from various sources is summarized in Table 1. These data are adequate for a broad discussion of thermochemical processing methods, but for design of specific manure processing facilities manure production data for the particular case considered should be sought. The three major aspects of manure composition to be considered are water content, types of organic materials present, and elemental analysis.

The water content of manure as excreted is normally 75 to 90 percent. Usually thermochemical processing of manure is done at rather high temperatures; therefore, this water must be removed from the manure prior to, or during processing. As discussed in Chapter III of this report, drying is a rather expensive process with a very wide range of reported costs per ton of dry manure. Drying costs will make many proposed thermochemical conversion processes uneconomic. A less expensive route for thermochemical processing of manure is to produce animals in an arid climate where natural drying can be utilized to reduce the moisture content of manure to 10 to 30 percent. In some cases the need to dry manure can be circumvented during thermochemical processing by utilizing a sufficient pressure to keep the water in the liquid phase. As discussed later in this chapter, wet pyrolysis or oxidation is a rather expensive process which usually does not yield profitable products.

The types of organic compounds found in manure are not unusual as is shown in Table 1. Manure is largely cellulose and lignin. These materials are also available from wood and various plant wastes. If cellulose or lignin are needed in a particular chemical process, they can frequently be obtained in a more uniform, concentrated form from wood, agricultural plant wastes, or even municipal solid waste than from manure.

The protein which is present in manure is a potentially valuable material. This topic has been given thorough consideration in chapters IV and V. In the present chapter protein content of manure is considered only with respect to its potential for thermochemical conversion. This conversion of protein during thermochemical processing frequently is harmful in that the protein nitrogen is transformed into organic compounds which contaminate the desired products of thermochemical processing.

TABLE 1

PRODUCTION RATE AND COMPOSITION OF MANURE FROM MAJOR DOMESTIC ANIMALS

	Beef Cattle (1000 lb live weight)	Dairy Cattle (1000 lb live weight)	Poultry (5 lb live weight)	Swine (100 lb live weight)
Production Rate				
Total solids, lb/day/animal	3.62(l) 6.16(n) 7.2(ee)	6.80(l) 10.24(a) 9.06(v) 11.2(j)	0.59(bb) 0.66(a) 1.12(a)(v)	0.59(bb) 0.66(a) 1.12(a)(u)
BOD_5, lb/day/animal	1.02(l)	1.32(l) 1.88(v)	0.017(u)	0.20(bb) 0.34(u)
COD, lb/day/animal	3.26(l)	5.78(l)	0.059(u)	0.57(bb) 1.25(u)
Moisture Content				
As excreted, wt %	70-80(n) 85.88(l)	87.5(j) 87(l)	71(a) 71.6(a) 72.01-74.01(g) 75(j) 64.9(w)	84.0(u) 90.48(t) 91.96(t)
As handled, dry lot, wt %	20-25(n)	20(j)	20(j) 23.5(c) 28.85(c) 17.5(k) 24.97(l) 36.92(l)	
Composition (as % of total solids)				
Volatile solids	80-90(a)	90(j) 87.9(aa) 80-90(aa) 83.5(aa) (l)	77(a) 76(j)(u)	79.7(bb) 77(a) 85(u) 80.95-83.60(t)
Ash	35-44(g) 12.8(l) 17.2(c) 28.9(dd)	15.0(d) 16.5(d)(l) 36.8(p) 26.1(z)	26(j) 35.93(w) 8.25(c) 19.6(l)	
[illegible]	0.3(c) 0.5(dd) 0.8(e)			
[illegible]	41.2(c) 42.6(dd)			
[illegible]	5.7(c) 5.5(dd)			
[illegible]	33.3(c) 23.7(dd)			
Nitrogen, %	2.74(e) 3.0-4.0(x) 3.5-3.8(x) 2.3(c) 2.9(dd)	2.52(x) 3.5(a) 2.2(r) 3.9(l) 1.5(x) 5.4(l) 2.0(aa) 6.0(x)	5.5(a) 3.57-5.77(g) 2.29-3.28(h) 2.27(l) 5.8(w)	4.0(a) 4.5(a) 4.5(u) 7.54-10.28(t)
Phosphorus, %	0.95(g) 1.3-2.1[P_2O_5](x) 1.0-2.5[P_2O_5](n)	0.52[P_2O_5](r) 0.7(p)	2.81-2.77(g) 0.99(l) 1.39(l) 2.27(l) 1.69(x) 1.07-1.91(t)	1.94-2.61(t) 2.7[P_2O_5](u)
Potassium, %	1.5-3.0(x) 2.02[K_2O](x) 2.16(x)	1.49[K_2O](r)	2.[illegible]-2.86(g) 2.1(a) 0.96-1.21(h) 1.79-1.88(l)	1.4(a) 4.3(a) 2.06-3.10(t) 4.3[K_2O](u)
[illegible]		7.7(d) 20.9(d) 18.9(d)	1.76(l) 2.05(c)	
[illegible]		18.3(d) 35.5(d) 31.7(d)		
Fiber	17.74(g)	13.4(l) 23.5(p)	2[illegible].38(l) 16.90(l) 15.66(w)	
Protein	15-20(g) 17.87(z)	15.6(l) 37.5(g)	11.95(l) 28.78(l) 10.19(w) 11.05(w)	
Calcium, %	1.87(n) 0.67(n)	4.0(z) 2.8(p)	9.47-11.58(g) 5.33(l) 5.56(l)	
[illegible]	.07(n)		0.79-0.96(g)	
Magnesium, %	0.5(n) 0.59(n)		0.91-1.12(g)	
[illegible]	1.17(u)			
[illegible]	2.76(u)		0.86-0.97(g)	
[illegible]		2.2(z)	3.03-4.94(x)	

(a) Loehr, 1970-1047
(b) Garner, et al, 1973-1011
(c) Smith, et al, 1971-1228
(d) Smith, et al, 1971*
(e) Fiegal, 1972*
(f) Kumar, et al, 1972-1087
(g) Robertson, et al, 1970-1081
(h) Anon, Poultry Digest, 1970-1206
(i) Parker, et al, 1959-1007
(j) Sobel, 1966-1067
(k) Dillrich, 1966-1076
(l) Witzel, et al, 1966-1078
(m) Hart, 1972*
(n) Hart, et al, 1972*
(o) Monnaghan, et al, 1972-1108
(p) Lipstein, et al, 1971-1154
(q) Johnson, 1972-1074
(r) Nye, et al, 1971-1199
(s) Albin, et al, 1971-1002
(t) O'Callaghan, et al, 1971*
(u) Taiganides, et al, 1964-1071
(v) Okey, et al, 1969-1066
(w) El-Sabban, et al, 1969-1074
(x) Edwards, et al, 1969-1025
(y) Long, et al, 1969-1042
(z) Anthony, 1969-1003
(aa) Bloodgood, et al, 1969-1010
(bb) Schmid, et al, 1969-1015
(cc) Schlesinger, et al, 1972-1136
(dd) Herzog, et al, 1973-1013
(ee) Coleman, 1973*

*Not abstracted

The elemental analysis of manure determines the relative amounts of elements which are available in manure for manipulation by thermochemical processing into desirable products. Elemental analyses for manure from beef cattle are given in Table 1. Since manure must compete with other raw materials for thermochemical processing, a typical feedlot manure is compared with coal, oil shale, and municipal solid waste in Table 2. The moisture content listed for manure in this table is 30 percent, a water content frequently observed in manure when scraped from beef feedlots in semi-arid climates.

Raw materials with high hydrogen and carbon contents are favored for conversion to synthetic crude oil and natural gas. Since hydrogen is more valuable than carbon, the hydrogen content is more critical than the carbon content in consideration of materials for thermochemical processing.

Oxygen in these raw materials has a negative value, since it reduces the heating value of the raw material. Oxygen removal by thermochemical processing also results in loss of valuable hydrogen and carbon. Sulfur and nitrogen in these raw materials usually represent potential pollution problems, and cause contamination of the synthetic crude oil and gas which might be produced from them.

In general, all these raw materials for thermochemical processing are similar and the selection of one or the other of them will depend on costs and large scale availability.

In summary, manure contains large amounts of water which generally must be removed to permit thermochemical processing. As a feedstock for thermochemical processing, manure must compete with other potential raw materials such as coal, oil shale, municipal solid waste, and plant residues from forestry or agricultural operations. The value of manure as a raw material for thermochemical processing is unknown. To determine its value much more research is necessary as indicated throughout this chapter.

PRODUCTS FROM THERMOCHEMICAL PROCESSING OF MANURE

Diamonds could be made from manure, but only an infinitesimal amount of manure would be disposed of in this manner and, moreover, diamond production would be more expensive than if other carbon sources were used. In a similar manner it might be hoped that some chemical whose value was very high could be produced by thermochemical processing of manure. This is only an idle wish since manure contains largely ordinary substances found in nature such as cellulose, lignin, protein, and ash. The products which have been produced from manure are common materials having a low value

TABLE 2
ELEMENTAL ANALYSES OF FEEDSTOCKS FOR THERMOCHEMICAL PROCESSING***

Material Source	Lignite N. Dakota, Beulah Seam	Oil Shale Colorado, Green River Deposit	Bituminous Coal, Pennsylvania Pgh. Seam	Subbituminous Coal, Wyoming, Monarch Seam	Solid Waste Average Municipal Refuse	Beef Cattle Feedlot Waste
Carbon	42.4	23.8**	76.6	54.6	35.4	42.6
Hydrogen	6.7	2.6	5.2	6.4	4.4	5.5
Oxygen	43.3	12.3	6.2	33.8	28.2	23.7
Nitrogen	1.7	0.5	1.6	1.0	0.4	2.8
Sulfur	0.7	1.0	1.3	0.4	0.2	0.5
Ash	6.2	59.8	9.1	3.8	31.4*	24.9
Total	101.0 (sic)	100.0	100.0	100.0	100.0	100.0
Moisture	34.8	0.2	2.6	23.2	20.7	29.1

*Includes ash, metals, glass, and ceramics.

**Includes 4.6 percent carbon as carbonate.

***From Feldman [1971-1088] except for beef cattle feedlot waste which is from Herzog et al [1973-1013] per pound but a large market. Large potential markets offer the opportunity for disposal of significant amounts of manure, if economics are favorable.

Table 3 tabulates potential products from the thermochemical processing of manure and lists pertinent references. Three of these products, methane, electricity, and ammonia, require no further discussion since they are products with established markets and prices. These prices can be expected to increase, however, since crude oil and natural gas are becoming more expensive.

Oil produced from manure vi pyrolysis or reaction with carbon monoxide will contain considerable amounts of nitrogen and oxygen plus small amounts of sulfur. An analysis made by APPLE [1972-1007] of oil produced by reaction with carbon monoxide reports 4.2 percent nitrogen, 7.3 percent oxygen, and 0.37 percent sulfur. These large amounts of nitrogen and oxygen cause the heating value of the oil produced from manure to be about 15,200 BTU per pound. That of conventional fuel oil is 18,600 BTU per pound, some 18 percent higher. The presence of organic nitrogen in the oil may contribute to oil instability during storage and to nitrogen oxide problems during burning. The rather low sulfur content is an advantage of manure-derived oil. Refining of oil produced from manure into gasoline and petrochemical products would be costly due to the presence of nitrogen and oxygen.

Oil produced from manure via pyrolysis or reaction with carbon monoxide is certainly less valuable than ordinary crude oil for the reasons discussed above. HALLIGAN and SWEAZY [1972-1060] placed a value of $2.00 per barrel on it contrasted to the $5.00 value assumed by FRIEDMAN et al [1972-1047]. Further investigations are required to accurately estimate the market value of the oil.

Hydrogenation of manure could potentially produce liquid hydrocarbons without significant amounts of nitrogen and oxygen, but manure is more readily reacted with carbon monoxide than with hydrogen as is discussed later in this chapter.

The char produced from pyrolysis of manure is characterized by a high ash content, which thus results in a rather low heating value. MASSIE and PARKER [1973-1020] have reported an ash content of 40 percent, and a heating value of 6,390 BTU per pound for char from a continuous manure pyrolyzer. The heating value for a typical coal is double that, about 13,000 BTU per pound. Another related problem with utilizing manure char for fuel is that about eight times as much ash must be disposed of per BTU used if manure char were to be employed instead of a good grade of coal. Since volatile matter has been removed from manure char, it would be more difficult to ignite in conventional boilers than would coal.

TABLE 3

PRODUCTS FROM THERMOCHEMICAL PROCESSING OF MANURE

Product	Process	Selected References
Char	Batch Pyrolysis	White and Taiganides [1971-1260] (small batch data on various manures) Garner and Smith [1973-1011] (beef manure) Schlesinger et al [1972-1137] (detailed analysis of char)
	Continuous Retort	Massie and Parker [1973-1020] (experimental data for small retort) Parker et al [1973-1025] (projected process flow sheet and economics)
	By-product from Ammonia Synthesis Gas Production	Herzog et al [1973-1013] (initial experimental data)
Oil	Pyrolysis	Garner and Smith [1973-1011] (analysis of liquid products, simulated continuous pyrolysis data) Massie and Parker [1973-1020] (oil yield from small continuous retort)
	Reaction with Carbon Monoxide	Friedmann et al [1972-1047] (experimental data and projected economics) Fu et al [1972-1048] (experimental data, process improvements)
	Reaction with Hydrogen	Friedman et al [1972-1047] (experimental data)

Methane (High BTU Gas, Substitute Natural Gas)	Hydrogasification	Feldmann [1971-1088] (mentions manure, economics, and experimental data for municipal solid waste) Halligan and Sweazy [1972-1060] (preliminary calculations for manure)
	Gasification	No specific references for manure
	Anaerobic Digestion	See discussion in Chapter IV
Low BTU Gas	Pyrolysis	Massie and Parker [1973-1020] (experimental data for small retort)
Electric Power	Boiler Fuel	No specific references for manure
	Low BTU Gas via Pyrolysis	Parker et al [1973-1025] (projected flow sheet and economics)
Fertilizer	Ammonia via Synthesis Gas Produced by Partial Oxidation	Halligan and Sweazy [1972-1060] (concept proposed) Herzog et al [1973-1013] (experimental data)
	Ammonia By-product from Pyrolysis	Parker et al [1973-1025] (recovery shown on flow sheet)
	Potassium and Phosphorus in Ash after Combustion	Davis et al [1972-1032] (laboratory data and suggestion for use)
Misc. Products Ceramic Tile	Prepared from Manure Char or Ash after Pyrolysis	McKenzie's process [1972-1183, 1187, 1215] (brief news articles)

The low sulfur content reported for manure char, 0.3 percent, is an advantage of manure char over many coals, [SCHLESINGER et al, 1972-1138]. The same reference reports a nitrogen content of 1.1 percent for manure char which is not greatly different from that of coal.

For the reasons listed above, the value of manure char as a fuel will be considerably less than that of coal. Manure char may have potential as an activated carbon, but no results have been published. Pyrolyzed sewage sludge has been reported to have modest capabilities as an activated carbon [BEECKMANS and NG, 1971].*

Low BTU gas is a broad term for combustible gas mixtures whose composition is such that they could not be economically upgraded for substitute natural gas (SNG). The usual application for low BTU gases is power generation and industrial fuels since gas distribution facilities are designed for high BTU gas. PARKER et al [1973-1025] planned to directly utilize low BTU gas from their manure retort for power generation.

Low BTU gases contain large amounts of nitrogen which result from the use of air to energize a pyrolysis or a gasification reaction via partial oxidation. This nitrogen contamination can be avoided by using pure oxygen instead of air as the source of oxygen. The economics of producing high BTU gas with pure oxygen as a reactant, or low BTU gas with air as a source of oxygen has not yet been resolved for coal or manure processing.

Production of fertilizer from manure as a means of manure disposal appears to involve a contradiction since current manure management problems are the results of manure being uneconomical as a fertilizer. If, however, the fertilizer values in manure could be concentrated as a by-product from thermochemical processing of manure, economical fertilizer products might result. This is proposed by PARKER et al [1973-1025] where sales of ammonium sulfate from the manure pyrolysis plant were calculated to produce 28 percent of the total income. Complete conversion of manure to ammonia can be achieved by making synthetic ammonia from synthesis gas manufactured from manure as proposed by HALLIGAN and SWEAZY [1972-1060].

After combustion of manure some potassium and phosphorus fertilizer values remain in the ash. This material has been recommended as a fertilizer and soil conditioner by E. G. DAVIS et al [1972-1032]. The manure ash being considered for fertilizer may also contain materials, such as common salt, which are harmful to plant growth.

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*Not abstracted

AVAILABILITY OF MANURE FOR THERMOCHEMICAL PROCESSING

The preponderance of manure production is from cattle (88.4 percent) with hogs, poultry, and sheep contributing 5.9, 4.9, and 0.8 percent respectively according to L. A. ANDERSON [1972]. Of the total manure produced, ANDERSON calculates that only 13 percent is produced in sufficiently localized amounts, such as feedlots having 1000 head or more, to be collected for thermochemical processing. This may be an optimistic assumption as to the quantity of manure which can be collected for thermochemical processing since many papers on thermochemical processing assume manure availability from 0.2 to 2 million feedlot cattle per processing plant as noted by HALLIGAN and SWEAZY [1972-1060], FRIEDMAN et al [1972-1047], and PARKER et al [1973-1025].

Table 4, taken from ANDERSON [1972], tabulates the amounts of manure and other solid wastes potentially available for thermochemical processing. These data show that the quantity of manure available for thermochemical processing is only one third that of municipal solid waste. ANDERSON also stated that conversion of manure to oil would have supplied less than one percent of the nation's crude oil usage in 1971. This information may be summarized by stating that manure is not the solution to the energy crisis, but that the energy crisis may contribute toward the solution of manure disposal problems.

Both coal and oil shale are concentrated in large quantities, thus plants producing 50,000 barrels or more of oil per day could be constructed. This size of plant could operate on a scale which could compete with conventional oil refineries whose size ranges up to 600,000 barrels per day.

Manure will not be available on such a large scale in a central location. For example, if one barrel of oil were produced per ton of dry manure processed, a 50,000 barrel per day capacity plant would require manure from 14 million cattle.

These size factors are important in determining the investment required per ton of manure processed. Engineering experience has shown that, in general, a chemical plant processing 5000 tons of manure per day would require approximately 2.5 times the investment per ton of manure processed that a plant processing 50,000 tons per day of manure would require, if this large amount were available at one place.

Sufficient manure is available in central locations to build 1000-tons-per-day ammonia plants based on synthesis gas from manure as observed by HERZOG et al [1973-1013]. This is a typical size for modern ammonia plants.

TABLE 4

ESTIMATES OF AVAILABLE ORGANIC WASTES, 1971*

Source:		Total Organic Wastes Generated	Organic Solids Available for Processing
Manure	Million tons/year	200	26.0
Urban refuse	do	129	71.0
Logging and wood manufacturing residues	do	55	5.0
Agriculture crops and food wastes	do	390	22.6
Industrial wastes	do	44	5.2
Municipal sewage solids	do	12	1.5
Miscellaneous organic wastes	do	50	5.0
Total	do	880	136.3
Net oil potential	Million barrels	1,098	170
Net gas for fuel potential	Trillion cubic feet	8.8	1.36

*ANDERSON [1972]

Another advantage that oil shale and coal have over manure as a raw material for thermochemical processing is the amount of research which has been directed toward their utilization in the past. Several demonstration-size oil shale plants have been built in the past 20 years, whereas manure has been thermochemically treated only in bench scale units or small pilot plants. Similarly the Office of Coal Research has supported a large amount of coal processing research in recent years.

Manure processing research can be made more rapid and efficient by utilizing information available from oil shale and coal studies, but still research and engineering problems unique to manure must be defined and solved. Throughout this discussion of thermochemical processing of manure, references will be made to oil shale and coal as a means of utilizing existing information.

COMBUSTION

Two publications have reported small scale experimental studies on the combustion of manure in rotary kilns and fluidized beds [DAVIS, 1972-1032] and in a model laboratory incinerator [SOBEL and LUDINGTON, 1966-1068]. These small scale experiments are not particularly helpful in extrapolating to commercial scale units. LOEHR [1968-1027] has estimated the cost of manure incineration to be about that for incineration of municipal solid wastes, an investment of $3000 per ton of daily capacity and operating costs of $5.00 per ton in 1968. It is presumed that this estimate assumes manure of about 30 percent water content, which is about that found in municipal solid waste.

Use of manure as a boiler fuel would permit recovery of energy in manure as electrical power. A 110-megawatt electrical power station could be fueled by the manure from 600,000 beef feedlot animals, assuming 7.2 pounds of dry matter having a heating value of 6,000 BTU per pound per animal, and a thermal efficiency of 35 percent. Larger plants could be built by employing both coal and manure for fuel. Being equipped to burn varying ratios of manure and coal would give the plant considerable flexibility. Since manure is a low-sulfur fuel, it would be possible to burn relatively high sulfur coal and still meet standards for sulfur dioxide emission.

Combined firing of coal and municipal solid waste is now being tested in St. Louis with considerable success as cited by HORNER and SHIFRIN, INC. [1972]. Only about ten percent of the energy is being supplied by refuse and 90 percent by coal.

There has been no information published regarding combined firing of coal and manure under boilers. Initially two major technical questions can be raised. Firstly, would organic nitrogen in the manure create nitrogen oxide concentrations significantly beyond those expected from combustion of coal alone? Secondly, would the ash from manure create problems in boilers and fly ash recovery systems beyond those of having to process more ash per unit of electricity generated? These questions should first be answered for conventional firing of pulverized coal. If the answers were not favorable, fluidized beds should be considered as should the use of char from pyrolyzed coal and manure mixtures. This latter option would also permit the production of oil from manure and coal.

As an example of the kind of problems to be encountered, consider the presence of salt in manure. Sodium and potassium chlorides greatly increase the corrosion of boiler tubes, particularly when high steam temperatures are desired. For a given chloride content, coals with high ash are less corrosive than coals with low ash as cited by WYATT and EVANS [1963]. Since manure is high in both chlorides and ash, its corrosion potential is not obvious. A further complication is that the salt content of manure can vary widely depending on the amount of salt fed the animals. For a ration with one percent salt, the sodium content of the manure was 0.86 percent. If no salt were intentionally fed to the animals, the sodium content was only 0.15 percent [KLETT et al, 1972-1080]. It should be noted that animals fed no salt gained just as efficiently as animals fed varying amounts of salt up to the one percent level.

The preceding paragraph illustrates the interrelatedness of many factors in considering the possibility of manure as a boiler fuel, from the nutritionist who determines the rations for the feedlot animals to the metallurgist who specifies alloys for the boiler tubes and predicts the expected amount of corrosion.

A large electric power generation facility designed to burn combinations of coal and manure would have political problems as well as technical problems. Several independently owned feedlots, a utility company, and federal and state agencies responsible for different aspects of the facility would have to enter into design and operation of the facility in a spirit of cooperation.

PYROLYSIS

BATCH PYROLYSIS OF MANURE

Pyrolysis is simply a chemical decomposition of organic material by means of heat. Pyrolysis provides a direct means for converting manure into four products: char, oil, fuel gases, and water containing dissolved organic compounds. The potential utility of these streams is discussed earlier in this chapter.

Several authors have reported yields for batch pyrolysis of manure. WHITE and TAIGANIDES [1971-1260] pyrolyzed swine, beef, dairy, and poultry manure. The results for pyrolysis of each of these materials were similar. These authors did not report the composition of the manures employed prior to pyrolysis, so it is not possible to relate pyrolysis yields to the original manure composition.

GARNER and SMITH [1973-1011] have pyrolyzed steer manure under carefully controlled conditions. Their emphasis was on composition of the liquid products. Many oxygenated and nitrogenous organic compounds were identified, but none was present in sufficient concentration for profitable separation. These same authors reported differential thermal analyses and differential gravimetric analyses for manure. They estimated the cost for disposal of manure by pyrolysis to be rather high -- $5.60 per ton. It should be stressed that their calculations were for manure containing 80 percent moisture.

Bureau of Mines personnel have pyrolyzed a wide variety of municipal, industrial, and agricultural wastes, in facilities originally employed for testing coal [SCHLESINGER et al, 1972-1137, 1138; SANNER and WOLFSON, 1971; and SANNER, et al, 1970-1082]. One set of their data is given in Table 5.

It should be stressed that yields for pyrolysis of manure are a complex function of many variables. These variables include manure composition and particle size, heating rates, maximum temperature, and pressure in the pyrolysis chamber. For particular pyrolysis schemes other factors may also influence the product yields; among these are the purging of the reacting chamber with gases or the allowing of liquid products to reflux back into the pyrolysis chamber. For these reasons considerable judgement must be exercised in drawing conclusions from published data for batch pyrolysis of manure.

CONTINUOUS PYROLYSIS OF MANURE

Superficially, pyrolysis of manure or any other material is a simple process: heating in the absence of air at a sufficient temperature for a sufficient time to decompose the organic material present; then cooling. When one attempts to plan an economical commercial pyrolysis plant with minimum pollution potential many major design problems arise, some of which have not been solved. It should be noted that currently pyrolysis of solids is employed only for preparation of activated charcoal and specialty fuels such as charcoal and coke. Commercial pyrolysis of coal or oil shale for fuel is not currently economical in the United States. The energy crisis and pollution control may, however, make large scale pyrolysis of coal, oil shale, or even manure practical in the near future.

TABLE 5

PRODUCTS FROM PYROLYSIS OF MANURE

	Batch Pyrolysis at 900°C**	Continuous Retort***
Moisture Content Feed %	3.6	29.1
Ultimate Analysis Feed Wt %		
Carbon	41.2	*
Hydrogen	5.7	*
Oxygen	33.3	*
Nitrogen	2.2	*
Sulfur	.3	*
Ash	17.2	22.0
Yields (Per ton of wet feed)		
Gas [Std (60 F) ft^3]	13,940	16,610
Oil [Bbl (42 gal)]	.31	.96
Water phase (gal)	38.3	89.5
Char (lb)	726	526
Gas Composition Vol %		
Oxygen	*	1.72
Nitrogen	*	49.83
Carbon Dioxide	24.5	14.06
Carbon Monoxide	18.0	17.72
Hydrogen	27.5	10.2
Methane	22.7	3.07
C_2^+	7.3	*
Char Wt %		
Carbon	49.4	*
Hydrogen	.4	*
Oxygen	.4	*
Nitrogen	1.1	*
Sulfur	.3	*
Ash	48.4	40
Heating Values		
Feed BTU/lb (dry)	7,110	7,630
Gas BTU/ft^3	450	123
Char BTU/lb (dry)	7,290	6,390

*Not reported
**Schlesinger [1972-1138]
***Massie and Parker [1973-1020]

The central problem in the design of a continuous manure pyrolysis facility is the transport of heat to the manure and, if possible, the recovery of the heat from the products. On a laboratory scale, this is readily accomplished by external heating of the retort containing the manure, but to extrapolate this concept to a commercial scale or even to a pilot plant scale becomes difficult.

To increase the rate of heat transfer to the manure contained in a retort, an obvious solution is to stir the manure within the retort. Injected gases may be used to mix the solids within the retort to cause increased heat transfer rates from the heated wall, either as a fluidized bed or while the solids are being entrained through the retort by the gases. This latter method has been attempted on municipal solid wastes but solids feeding problems frustrated efforts to obtain a significant amount of data on the pilot unit [McFARLAND et al, 1972-1106]. An externally fired 30-inch diameter fluidized bed reactor is shown for pyrolysis of noncompostable wastes in the Hercules waste disposal system. [WINER, 1971, as reported by BAILIE and BURTON, 1972].

Another procedure for supplying energy for pyrolysis of organic solids is to mix hot inert solids with those organic solids being pyrolysed. BAILIE and ISHIDA [1972] have considered this procedure in which fluidized beds were employed both to heat the inert solids and to mix the hot inert solids with the municipal solid waste to be pyrolyzed. The TOSCO oil shale retort mixes hot ceramic balls with the organic material to be pyrolyzed. These balls must then be separated from the spent char, reheated in a separate furnace, and then mixed with additional material being pyrolyzed. This rather complex retorting method has recently been tested with coal [CARLSON, et al, 1973-1005] and presumably could be employed with manure.

Still another approach for the transport of heat to the solids being pyrolyzed is to mix preheated gases into the solids either as a fixed bed, a fluidized bed, or while entrained in the heated gas. While this approach is mechanically simple, large volumes of gas must be both circulated and heated resulting in a considerable investment for compressors and either furnaces or heat exchangers. The use of furnaces to heat the gas employed to retort oil shale in a moving bed retort has been reported [CAMERON, 1964].

The cost of furnaces to preheat the gases used to pyrolyze organic solids can be avoided by burning fuel or a portion of the solid waste with air, then using the hot combustion gases to pyrolyze manure or other organic materials.

The general concept of partial combustion to energize the pyrolysis reaction can be applied to many types of retorts. Monsanto has employed a rotating kiln in the "Landgard" system for management of municipal solid wastes [MALIN, 1971]. Workers at the University of West Virginia have stressed the utilization of fluidized beds both for pyrolysis and for incineration of municipal solid wastes [BAILIE and ISHIDA, 1972; BAILIE and BURTON, 1972]. The only continuous manure retort reported in detail has employed air injection to energize pyrolysis reactions in a moving bed [MASSIE and PARKER, 1973-1020]. Figure 1 illustrates this recently developed retort. Manure enters the top of this retort and char is discharged from the bottom. Counterflow circulation of gases serves to transport heat upward in the retort to form manure drying and pyrolysis zones in the upper section of the retort. Two gas injection cycles are employed. Air is injected to generate heat at a combustion front which moves downward in the retort when the lower portion of the retort is cold. The injected air is diluted with oxygen-free gas to lower the temperatures at the combustion front, so that the ash in the manure cannot fuse and form clinkers. When the combustion front nears the bottom of the retort where the associated high temperatures might damage the grate, air injection is stopped and only oxygen-free gas is injected. The oxygen-free gas cools the lower portion of the retort and continues the pyrolysis and drying of manure in the upper portion of the retort. When the lower half of the retort has cooled, air injection is again resumed.

Feasibility of this retort has been demonstrated in a 6-inch pilot model. Table 5 reports the yield of products from this retort. A major difference in the list of observed pyrolysis products from the continuous retort and that reported for batch pyrolysis of manure is the yield of liquid organics. The continuous retort yielded about one barrel of oil per ton of manure processed in contrast with the 0.3 barrel per ton reported for the batch pyrolysis. These data show that manure pyrolyzed in the continuous retort produces more oil per ton than is reported for average Colorado oil shale (20-30 gallons per ton). The increase in oil yield over that of batch pyrolysis is due to the rapid removal of pyrolysis products from the retort by the circulated gases. A similar high yield of over 50 gallons per ton was reported when a helium purge was employed in a simulated continuous manure pyrolyzer [GARNER and SMITH, 1973-1011].

Conceptual process flow sheets have been prepared for a commercial plant using the Texas Tech University retort and costs estimated by PARKER et al [1973-1025]. For a plant processing 2,000 tons per day of 30 percent moisture manure an investment of 14.7 million dollars has been estimated. When credit is taken for electric power generated and ammonium sulfate produced by this plant, the annual income exceeds the operating expenses, including maintenance, by $846,000 if the manure entering the plant be considered to have zero value. If no credit be taken for oil and char produced, the cost per ton of manure processed is $3.71 for a 14 percent rate of

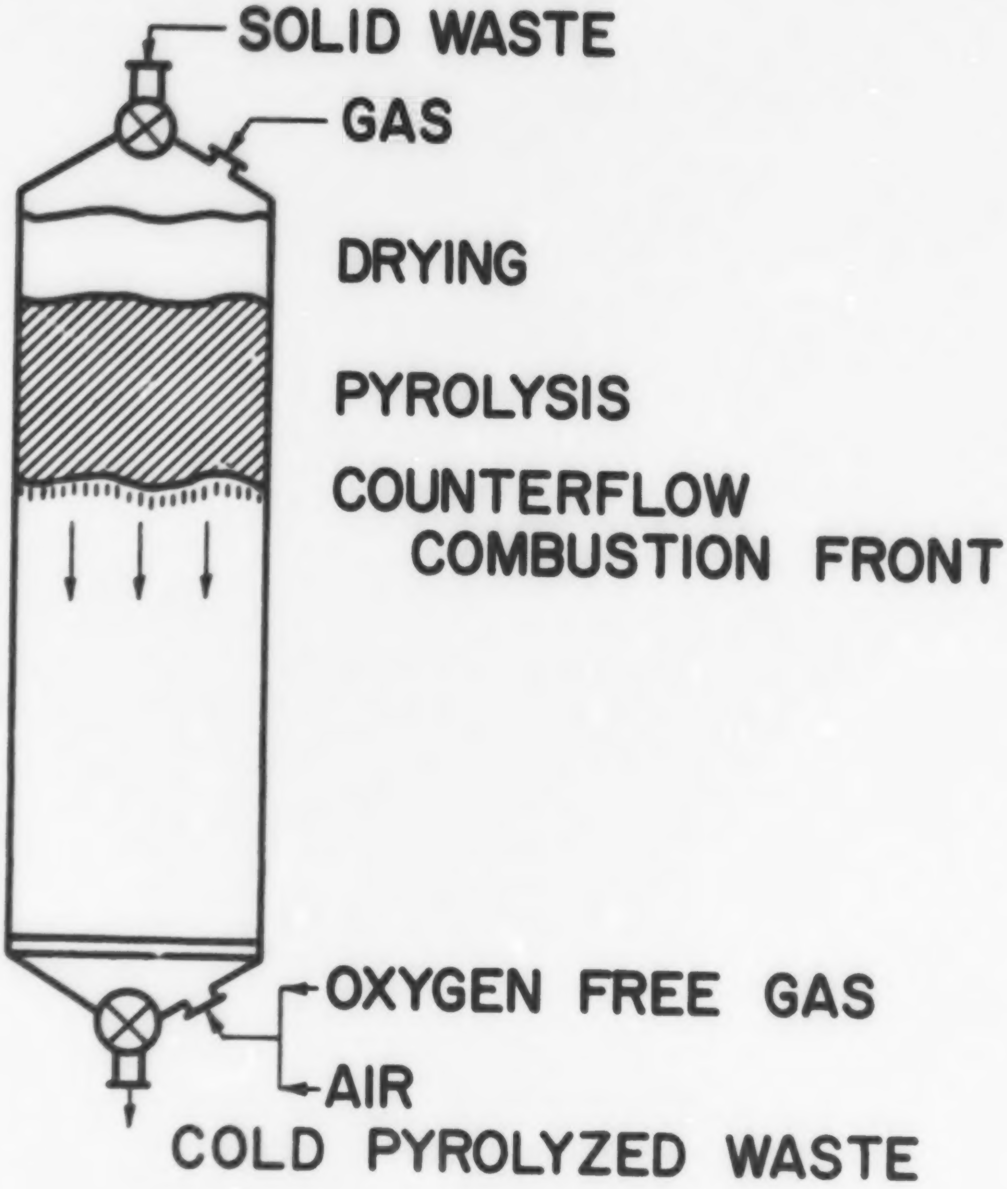

FIGURE 1. CONTINUOUS RETORT SCHEMATIC

return on industrial economics and $0.70 for municipal economics as described in Table 6.

The preceding pyrolysis methods, with energizing by partial combustion of the solids being pyrolyzed, result in pyrolysis gases which are diluted with nitrogen and combustion gases. For a price, dilution with nitrogen can be avoided by using oxygen instead of air to oxidize the fuel as has been proposed for several coal pyrolysis and gasification methods. Cyclic operation of the pyrolysis processes can also be utilized to produce pyrolysis gases not contaminated with nitrogen or combustion gases. An alternative approach is to limit the nitrogen content of the mixed pyrolysis gases and combustion gases so that the resulting gas mixture is suitable for conversion to ammonia synthesis gas. This approach was proposed by HALLIGAN and SWEAZY [1972-1060] and is being tested in the laboratory [HERZOG et al, 1973-1013]. Their results have established that manure pyrolysis can be energized by the air which supplies the nitrogen required in ammonia synthesis gas. This is a significant conclusion, but considerable more research will be required to scale up this process for converting manure to ammonia synthesis gas, and to estimate its economics.

APPRAISAL OF MANURE PYROLYSIS METHODS

The preceding section illustrates that there are many ways to pyrolyze manure. There are insufficient experimental data and process economics to identify any one procedure as being the most desirable. This determination can not be made final until after commercial pyrolysis plants have been built and operated. It is appropriate now to make some tentative judgements regarding desirable types of pyrolysis processes to facilitate future research. One way to make this appraisal is by analogy with other pyrolysis industries.

Oil shale retorting has been investigated since the early 1800's, and there has been occasional production of shale oil prior to the availability of crude oil or when there was an anticipated shortage of crude oil. Two of the most intensively researched modern oil shale retorts, the Union Retort and the Bureau of Mines Gas Combustion Retort [MATZICK et al, 1968], employ a moving bed type pyrolyzer with combustion of a portion of the spent oil shale supplying the energy for the reaction. This analogy would suggest that the retort shown in Figure 1 or a similar retort would be a desirable manure pyrolyzer. It should be noted that the retort does not have internal gas distributors as employed in the gas combustion oil shale retort. These internal gas distributors have been a major problem in gas combustion retort scale-up studies by the Bureau of Mines and later by a group of six major oil companies [RUARK et al, 1971].

Manure is more easily ground to the small particle sizes required in a fluidized bed than is oil shale. For this reason, fluidized bed pyrolyzers energized by injected air or oxygen should also be given active consideration in current research. Whether the product obtained from the fluidized bed pyrolyzer should be high-BTU gas for conversion to substitute natural gas, low-BTU gas for use as industrial and utility fuel, or a gas suitable for ammonia synthesis gas will require detailed economic analysis. There is considerable attractiveness to the ammonia synthesis gas concept since this would release natural gas, now used for making ammonia, for other purposes.

The limiting parameters in the design of commercial manure pyrolysis plants may be mechanical factors such as particle agglomeration and elutriation in fluidized beds, crushing of manure fragments in large retorts, and gas-solids contacting efficiency in both types of pyrolyzers. These problems and perhaps other unanticipated problems must be defined by additional research before profitable commercial plants can be built.

CONVERSION OF MANURE TO OIL AND GAS BY REACTION WITH HYDROGEN OR CARBON MONOXIDE

Conversion of manure to either liquid or gaseous hydrocarbons is an appealing way to upgrade solid wastes into desirable products. The need for hydrocarbon fuels has been emphasized by the present energy crisis. This conversion of manure into convenient fuels has been accomplished in the laboratory. Commercial large scale application of these techniques is slowed by a combination of anticipated costs and technological problems. Much of the technology developed for conversion of coal and oil shale into convenient fuels can also be applied to the conversion of manure.

A conclusion reached by Bureau of Mines personnel is that organic materials having a cellulosic structure such as manure were more effectively processed into oil by treatment with carbon monoxide and water than with hydrogen. FRIEDMAN et al [1972-1047] have compared the action of carbon monoxide and hydrogen on manure and have suggested a reaction mechanism which involves the formation of the formate ion, which then reacts with carbohydrate-like materials to produce oil. The formate ion can exist only in liquid water; therefore, high pressures are required to prevent water vaporization at the temperatures required for the reaction to proceed. Typical reaction conditions are 660°F, 3,600 psia and a reaction time of one hour. Carbon monoxide consumption is 0.4 to 0.7 pounds per pound of manure, and the oil yield is about two barrels per ton of manure. To produce the carbon monoxide needed by the process, and the energy needed by the processing plant, another ton of manure might be required, reducing the net yield of oil per ton of total manure processed to about one barrel. This is the same oil yield reported for the continuous pyrolysis of manure. Most experimental work to date on this process has been in batch autoclaves, with only data for sucrose and municipal solid waste having been reported for a small continuous unit as cited by FRIEDMAN et al [1972-1047]. All processes which treat solids at high pressures can be expected to have problems with the feeding of the solids into the high pressure reactor on a commercial scale. In addition, this process may encounter difficulties in separation of manure ash from the oil produced.

FRIEDMAN et al [1972-1047] estimate that a plant converting manure from 200,000 beef feedlot animals into oil valued at $4.00 per barrel would have to charge $5.00 per ton of manure processed to break even. Their calculation did not consider income taxes and interest. If a ten percent discounted cash flow is required on the invested money and 48 percent income taxes are paid, a charge of $18.80 must be paid per ton of manure processed. Other economic data for this calculation are given in Table 6.

Steps have been taken to reduce these costs as noted by FU et al [1972-1048]. One major step is utilization of a carbon monoxide and hydrogen mixture instead of pure carbon monoxide for the reaction gas. Another proposed improvement is the reduction of the operating pressure and heat requirements by using a low-vapor-pressure oil to transport the manure into the reactor and supplying only enough water to facilitate the reaction. Even with these improvements it is expected that disposal of manure via reaction with carbon monoxide will be costly.

Natural gas is becoming scarce, therefore the production of methane from manure may appear desirable. There are three ways to accomplish this conversion. The method used in the past has been anaerobic digestion of manure as discussed earlier in this report. Although possible, it does not appear economic or more applications of the method would have been made since this is a well-known process. Another route is gasification of manure or manure char. There have been no experimental results reported for high temperature gasification of manure, but presumably the results from manure could be similar to results from coal, with appropriate allowance for manure's high ash content and low heating value. The third approach to production of methane from manure is hydrogasification which is the process of hydrogenation of organic materials at sufficiently high temperatures and pressures to convert them to gases. No catalyst is required.

FELDMANN [1971-1088] reported three hydrogasification experiments on municipal solid wastes, then proceeded to adapt previous experimental work and cost estimates for hydrogasification of coal and oil shale to gasification of municipal solid wastes. HALLIGAN and SWEAZY

TABLE 6

ECONOMIC CRITERIA FOR EVALUATION OF PROCESS COSTS*

	Public Ownership Economics	Private Ownership Economics
Size (Tons/Day)	2,000	2,000
Project Life (yr)	20	20
Depreciation Schedule	20 yr straight line	11 yr sum of digits
Interest Rate (year end discount)	6%	14% or 10%
Income tax	0.0	48%
Fixed Capital Investment, FCI	4.1 of major equipment costs	
Maintenance	4% of FCI/yr	
Salvage	5% of FCI	
Supervision	20% labor	
Payroll	25% (labor and supervision)	
Plant Overhead	50% of labor	
Working Capital	5% of FCI	
Insurance and Local Taxes	2% of FCI	

*[Parker et al, 1973-1025]

[1972-1060] extended the maximum methane yield calculations of FELDMANN to manure and they have estimated that 600,000 feedlot cattle could produce sufficient manure to produce 17 million cubic feet of methane per day. Their calculation includes using manure to manufacture the needed hydrogen and to energize the whole process. It was intentionally based on 4000 BTU/pound, a very conservative heat of combustion for manure.

Production of methane from manure will be greatly influenced by competition from other sources of organic solids, as discussed previously. The choice of methods for methane production, gasification versus hydrogasification, is also undecided. The first commercial coal-to-methane plants in the United States will be gasification types.

HYDROLYSIS, WET PYROLYSIS, AND WET COMBUSTION OF MANURE

This section considers the thermochemical processing of manure while it is still in a water slurry, thereby avoiding the need for drying. Superficially this is an attractive concept since artificial drying is expensive, and natural drying is dependent on weather conditions except in near-desert areas.

The natural substances occurring in manure can be decomposed by hydrolysis (reaction with water). With an acid catalyst, cellulose is hydrolyzed to glucose. Water, heat, and various chemicals will disperse lignin found in manure, as is practiced in making wood pulp for use in paper production. Proteins hydrolyze to amino acids. Another reaction is between proteins and lignins to form humus. There appears to be no reasonable way to produce marketable products from this group of possible reactions of manure in water. If there were a marketable product in the hydrolyzed manure mixture, its separation and drying would probably make its cost prohibitive.

One possible exception to this generalization is cooking of manure prior to refeeding, either for biological sterilization, improved digestibility, or to facilitate further processing. Cooking for refeeding is discussed in Chapter V. In spite of the limited potential for thermochemical treatment of manure slurries, work done in related fields, principally treatment of domestic sewage sludges, will be discussed in this report for the sake of completeness.

Thermal treatment of manure slurries is limited to temperatures below the boiling point of water unless elevated pressures are employed. With increased pressures, temperatures up to the critical temperature of water, 705°F, might be considered for thermal treatment of manure, but an operating pressure of 3,200 psia would be required. Up to this limit the designer of facilities for thermal treatment of manure slurries is free to choose any temperature he desires then employ the pressure necessary to prevent water evaporation (400°F--246 psia, 500°F--680 psia, 600°F--1,543 psia).

Elevated pressure cooking processes are utilized to condition sewage sludges, that is to make it easier to separate solids from water by gravity settling and filtration. BROOKS [1970] has reported on extensive laboratory heat treatment tests on various sewage sludges. KRONEBERGER [1972-1086] has described commercial equipment for heat treatment of sewage sludge. In this process steam is injected into a reactor containing the manure slurry to heat it. A heat exchanger is used to preheat the incoming manure and to simultaneously cool the cooked manure leaving the reactor.

The cost to heat treat 600 gallons per hour of pig manure slurry to 380°F, hold it for one hour, and cool it has been estimated by the authors, to be $7.15 per 1000 gallons if a ten percent rate of discounted cash flow is expected on the investment. Other economic data for this calculation are given in Table 6. After heat treatment, something must still be done with the resulting manure slurry. Based on experience with sewage sludge, the solids will be sterile and nonputrescible, but the water phase will have a high BOD. In some ways thermal treatment of manure could be considerd a substitute for treatment in an anaerobic digester.

T. ALLEN with Envirotech Systems, a firm which produces these heat treatment units commercially, states that testing has begun with one of these units as one step in the experimental manufacture of a protein cake from manure.

In the heat treatment process discussed above, the usual source of energy is in steam injected into the hot sludge holding tank. The need for fuel and for investment in a steam boiler can be avoided by injecting air into the holding tank. At high temperatures, above 300°F, rapid liquid phase oxidation of the manure will take place to release the heat needed for the process. Laboratory tests on various sewage sludges have been reported for this procedure by HURWITS et al [1965], but use of wet oxidation to condition sewage sludge has not been further reported. Costs may not be greatly different from the $7.15 per thousand gallons estimated for manure slurries. If serious consideration were to be given to thermal treatment of manure slurries, both steam heating and air injection should be evaluated.

To provide more complete disposal of manure slurries, sufficient air could be injected into reactors to oxidize most of the organic material present. This is the Zimpro process for oxidizing most organics in sewage sludges or other organic wastes. A general review of this process is given by TELETZKE [1964]. Because air requirements are proportional to organic solids content, air compression costs would be expected to be rather high when this process is applied to concentrated manure slurries. LUDINGTON [1971] reported a cost of $12.38 per ton of dry solids for processing poultry manure by this method. His information came from a 1967 paper, which was not available for this report, prepared by the developers of the process, the Zimpro Division of Sterling Drug. Since the economic assumptions behind the cost quoted above were not given, it should be used with caution.

CONCLUSIONS REGARDING THERMOCHEMICAL PROCESSING OF MANURE

UNCERTAINTY OF COST ESTIMATES

The basis on which conclusions are drawn regarding thermochemical processing of manure should be cost or, more hopefully, profit per ton of manure processed in an ecologically acceptable manner. These costs cannot be uniquely determined for the reasons listed below and discussed in the following paragraphs:

1. Economic environment in which the manure processing plant will function.

2. Value of products produced.

3. Uncertainties regarding processing plant investment and operating costs.

The competitive position in which a thermochemical manure processing plant would operate would depend to a considerable extent on the interest rates and income tax structures faced by the owner(s). If the processing plant were owned by a governmental or public entity which paid no income tax, and could issue low-interest bonds to build the plant, costs would be much lower than for a private corporation. PARKER et al [1973-1025] have shown that in one case the cost to process manure in these two economic environments differs by a factor of five--$0.71 versus $3.71 per ton of manure processed. The desirability and legality of a county or a manure disposal district owning and financing a manure processing plant needs to be explored in a locally coordinated effort by the concerned governmental agencies and the feedlot industry.

An associated problem regarding public and private economic environments is that processing costs quoted for different processes cannot be compared unless they are based on the same economic assumptions. Table 6 gives two sets of economic assumptions employed by PARKER et al [1973-1025]. These data have been used several times in this chapter to put various costs on a common basis.

The market value of standard products made from manure, such as ammonia and electricity, can be readily determined. The value of oil or char manufactured from manure is not obvious since these products are different from materials now being marketed. As an extreme example, if manure char were usable as an activated carbon, and its availability did not depress market prices, it might have a value of over $100 per ton; whereas, if the char must be sold as a rather high-ash boiler fuel its value could be under $3.00 per ton.

Another problem in calculating manure processing costs is that the various thermochemical processing methods discussed have been tested on a small scale only. These small-scale results must be used along with much engineering judgment to determine the size of commercial scale equipment; and then more judgment must be exercised in estimating investment and operating costs for the plant. These estimates are frequently biased with considerable optimism by personnel associated with the particular process.

RANKING OF THERMOCHEMICAL METHODS

The presently available knowledge is too limited to unambiguously rank thermochemical processing methods for manure. That ranking will occur automatically five to 25 years into the future as second generation manure processing plants are built. At this point it will be helpful to tentatively rank methods for manure processing based on the author's judgment, even though other individuals may rank them in a different order.

First choice is given to burning air-dried manure in utility boilers as a portion of the fuel. Coal would also be burned so that a plant of economic size could be built. The incremental investment required to handle manure instead of coal should be small relative to investment costs required for other thermochemical manure disposal methods. An intensive effort to obtain the data necessary to assess the feasibility and economics of this method ought to be made immediately. If negative answers are obtained in this investigation, more stress could then be placed on other methods for manure disposal.

Production of ammonia, using synthesis gas derived from manure as an intermediate step, is given second ranking. These plants could be built in economically competitive sizes, and the ammonia marketed near the point of production. A significant research program, supported by both EPA and private industry, has been undertaken to develop this process [HERZOG et al, 1973-1013].

Continuous pyrolysis of manure in retorts modeled after oil shale retorts is given third rank. The primary reason for this lower rank is that sufficient manure is not available in one location to build a retorting plant of sufficient size to compete with oil shale retorting plants and coal processing plants which might be built in the future. If it were necessary to produce liquid hydrocarbons from manure, this method is preferred over those which required elevated pressures.

Other methods for thermochemical processing of manure are given lower probability of commercial success. Wet oxidation and/or pyrolysis is ranked low because marketable products are not produced. Reaction with hydrogen or carbon monoxide is ranked low because of the anticipated high investments required for these plants which require feeding solids into a reactor at a high pressure, and the costs of producing the reactive gases, hydrogen or carbon monoxide.

NON ABSTRACTED REFERENCES (CHAPTER VI)

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VII.

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VIII.

ABBREVIATIONS USED

In addition to standard abbreviations for units of length, weight, etc., and to standard chemical symbols, the following abbreviations have been used in the body of this report or in the appendices.

AAAS	American Association for the Advancement of Science
ACS	American Chemical Society
AIChE	American Institute of Chemical Engineers
APF	Animal Protein Factor
ARS	Agricultural Research Service (of USDA)
ASAE	American Society of Agricultural Engineers
ASCE	American Society of Civil Engineers
ASCS	Agricultural Stabilization and Conservation Service (of USDA)
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
CRIS	Current Research Information System
CSAE	Canadian Society of Agricultural Engineers
DPW	Dehydrated Poultry Wastes
EPA	Environmental Protection Agency
FDA	Food and Drug Administration
FS	Fixed Solids
FWPCA	Federal Water Pollution Control Administration
FWQA	Federal Water Quality Administration
GE	General Electric
HS	Hamilton Standard

I&EC	Industrial and Engineering Chemistry
ID	Internal Diameter
ISLW	International Symposium on Livestock Wastes
MT	Metric Tons (= 2204.6 lbs)
ODR	Oxidation Ditch Residue
ORP	Oxidation Reduction Potential
OWRR	Office of Water Resources Research
SERL	Sanitary Engineering Research Laboratory
TS	Total Solids
TTU	Texas Tech University
USBM	U. S. Bureau of Mines
USDA	U. S. Department of Agriculture
USDI	U. S. Department of the Interior
USPHS	U. S. Public Health Service
VS	Volatile Solids
WPCA	Water Pollution Control Administration
WPCF	Water Pollution Control Federation
WRC	Water Resources Center
WRSIC	Water Resources Scientific Information Center

APPENDIX A

ANNOTATED BIBLIOGRAPHY

Literature on manure seems to be piled as high in the library as manure is on the guano-rich islands of the South Atlantic. The following abstracts represent a useful sampling of some of the best of the literature but are not a "true" or "valid" sample in the statistical sense for several reasons.

1. The early literature, applicable to a period of dispersed grazing animals in a pre-suburban rural setting, stressed the fertilizer value of manure. Its return to the land was considered to be an obligation to Nature. Such a solution is increasingly less applicable in the modern context. In consequence, many of the older contributions were left unread and unreported in this bibliography. References to them can be found in the papers abstracted here, in the Biological Abstracts, the Journal of Animal Science, Poultry Science, the publications of the various Agricultural Experiment Stations, and the popular farm press of the time.

2. The quirks of lagoons have been analyzed to a far greater extent than might be judged from a counting of these abstracts. Good papers giving sound design specifications for lagoons are apt to be on the shelf of almost anyone reading this report. Thus, under the pressures of time and space, many references found to such papers were not followed up -- and many an author is due an apology -- which is hereby sincerely extended.

3. The more exotic solutions or proposals are included to an extent well beyond their actual proportion in the literature and, probably, beyond what they deserve when evaluated on abstract merit. This was done deliberately. It was the goal of this report to present an evaluation of the state-of-the-art of manure management not as a textbook or design manual of approved current practice, but rather as a compendium of concepts which might aid some innovator by bringing to his attention similar work which might serve to bolster his solution. As one means of accomplishing this, a large number of news-note type papers, often anonymous or authored by a staff member of the journal in which they appear, are included. They frequently contain hints of developments well before formal papers on them have been prepared by the investigators, have run the gamut of review committees, and have served their time in the queue awaiting space availability.

The abstracts are grouped by year of appearance and arranged alphabetically by author within each year. The numbering system employed uses the year of appearance followed by a serial number beginning with '1001' for each year for papers abstracted in Appendix A, and beginning with 'C001' for those in Appendix C. In some cases confusion may result in that abstracts or oral presentations may be cited a year or two previous to formal publication.

Reference is given, where applicable, to abstracts appearing in the Selected Water Resources Abstracts published by the Water Resources Scientific Information Center. This is done by employing the serial number (consisting of W, a 2-digit designation for the year in which the abstract was published, and a serial number within that year) assigned by that organization.

Five volumes of "Solid Waste Management: Abstracts from the Literature" prepared for the U. S. Environmental Protection Agency by John A. Connolly and Sandra E. Stainback have appeared. These should be consulted since they contain abstracts of many papers not included in this volume. Where duplication of citation does exist, reference is made by the notation "C & S" followed by their assigned serial number.

A very comprehensive annotated bibliography on all aspects of animal wastes was prepared by J. B. McQuitty and E. M. Barber of the University of Alberta and published by Environment Canada. Again, many papers which they abstracted are not included in this volume. Reference to their abstracts where duplicate citation exists is made by the designation "McQ & B" followed by their assigned serial number.

A list of abbreviations used, an author index, and a subject index, follow the abstracts.

1912-1001
AMES, J. W. and GAITHER, E. W.
Barnyard Manure
Ohio Ag. Ex. Sta. Bull. No. 246 (p. 725-753 of series)

The constituents of manure had values quoted as follows: phosphorus 8.25 ¢/lb, nitrogen 15.84 ¢/lb, and potassium 5.3 ¢/lb. The liquid manure was much more valuable than the solid. Analyses of contents and evaluations of manures from various animals under diverse conditions are tabulated. "When cattle are fed for six months on cement floors, the increased value of the manure alone for two such feeding periods is sufficient to cover the cost of the floors."

1923-1001
THOMPSON, John T.
Can Sludge Be Economically Used as a Source of Heat?
Inst. of Sew. Purif. Jnl. and Proc. 22: 86-88

Three lines of attack have been explored:

1. Utilization of gas from septic digestion as carried out on a large scale at Birmingham (UK),
2. Burning of sludge in a furnace, and
3. Utilization of gas made by carbonizing sludge.

Methods 2 and 3 were subjects of experiments at Leeds reported in this paper. Wet cake (55 percent water) can be burned continuously at a rate of 52 lb of cake per hour per sq ft of grate. The calorific value, when dried at 100°C, is about one-third that of coal. "The work described has not yet produced a satisfactory method of utilising sludge as a source of heat, but it indicates that the solution probably lies in a specially designed furnace to deal with cake."

1927-1001
WILLIAMS, C. O.
Residual Value of Manure
Farming in South Africa 1: 441, 444

The phosphorus and potassium contents of a fertilizer tend to carry over from year to year whereas the nitrogen frequently becomes dissipated. Soil testing may lead to substantial savings in cost of fertilizer application.

1938-1001
PUFFELES, M. and ADLER, S.
The Effect of Sheep and Goat Manure on Some Mediterranean Red Soils
Soil Science 46: 273-278

Sheep and goat manure when added to red-sand soils is capable of improving their physical properties and counteracting the degradation to which they are subject. Analyses are given of the manure, soil, and mixture of manure and soil.

1940-1001
EDEN, A.
Coprophagy in the Rabbit
Nature 145: 36-37

Rabbits produce two types of feces: the familiar dry pellet type during the day, and a soft, mucus type "rarely observed because the animal collects them directly from the anus and swallows them again" at night. Experimental observations indicate that a rabbit may eat from 54 to 82 percent of its total fecal production.

1940-1002
LAMOREUX, W. F. and SCHUMACHER, A. E.
Is Riboflavin Synthesized in the Feces of Fowl?
Poultry Sci. 19: 418-423

More riboflavin has been found to be present in the feces of fowl than in their feed. Measurements reported in the paper indicate, however, that the increase occurs after defecation. "The rapid synthesis of riboflavin in feces following defecation makes it important that coprophagy be prevented in experiments concerning a deficiency of that vitamin."

1940-1003
SOUTHERN, H. N.
Coprophagy in the Wild Rabbit
Nature 145: 262

Southern reports observations on wild rabbits detected eating their feces and conjectures that their ability to extract further nourishment in this manner accounts for their being able to "hole up" when cold or danger may require it for periods of several days.

1942-1001
DeVILLIERS, J. I.
Precautions in the Use of Karroo-Manure
Farming in South Africa 17: 305-309

"Karroo manure, which consists of the droppings and absorbed urine of sheep and cattle and contains very little litter and impurities other than soil, is being used fairly widely in intensive farming areas to-day because of its low price and the reduced railage rates on manures and fertilizers, as well as the scarcity and increased cost of fertilizers." Karroo manure, while rich in nitrogen, potassium, and phosphoric compounds, often has a rather high sodium content and, thus, may have a deleterious effect on soil. Its use on non-sandy soil should be avoided, and on sandy soil should be minimal. Since its chemical content varies widely, karroo manure should be analysed, batch by batch, before use. Samples of soils on which it is used should be checked periodically.

1942-1002
HAMMOND, John C.
Cow Manure as a Source of Certain Vitamins for Growing Chickens
Poultry Sci. 21: 554-559

It has been demonstrated that contents of cow rumens may be higher in vitamins than was the feed. The feces may concentrate this several hundred times. Four experiments in feeding chicks rations which contained dried cow feces or extracts from them in alcohol or water are reported. It was concluded that "cow manure has a marked beneficial effect on growth in chicks if it is added to a diet deficient in riboflavin. Cow manure has no deleterious effect on the growth of chicks if it is added to a complete and balanced diet. Cow manure contains a factor that stimulates comb growth in both male and female chickens."

1942-1003
RILEY, Gardner M. and HAMMOND, John C.
An Androgenic Substance in Feces from Cattle as Demonstrated by Tests on the Chick.
Endocrinology 31: 653-658

In experiments on chick nutrition at Beltsville, it was observed that precocious comb and wattle growth resulted when either dried cow feces or a 60-percent-alcohol extract of dried cow feces was included in the chick diet. Further experimentation, reported in this paper, indicated that the development of testes and ovaries was retarded when chicks were fed dried cow feces, but not when fed feces from mature bulls.

1943-1001
BIRD, H. R. and MARVEL, J. A.
Relation of Diet to Hatchability of Eggs Produced in Batteries and in Open-Front Houses
Poultry Sci. 22: 403-410

While hatchability has been shown to vary with amount of sunlight and source of protein in the diet "greater improvement was brought about by feeding the feces of other birds kept in the battery and fed the same diet, the dried feces being fed as 10 percent of the diet. It appears that ingestion of feces might help to explain the good hatchability maintained by birds in open-front houses in spite of a low-riboflavin diet. . ."

1943-1002
BOHSTEDT, G.; GRUMMER, R. H.; and ROSS, O. B.
Cattle Manure and Other Carriers of B-Complex Vitamins in Rations for Pigs (Abst)
Jnl. Animal Sci. 2: 373

Free access to freshly collected cow manure permits pigs to avoid deficiencies in B-complex vitamins which may result "if only the usual 5 per cent or less ground alfalfa hay is fed in the ration."

"A very interesting light is shed on the helpful supplementary effect of cattle manure which is not due to any whole undigested corn it may contain."

1944-1001
HAMMOND, John C.
Cow Manure as an Ingredient of Turkey Diets
Poultry Sci. 23: 358-359

Fresh cow manure and cow manure dried at 47°C, 80°C, and 120°C were fed to poults as 10 percent of their diet as substitutes for alfalfa leaf meal in a diet already adequate in vitamin A and nearly so in riboflavin.

Livability, growth rate, and efficiency of feed utilization were unimpaired. Drying at 80°C to 120°C is preferable since bacteria pathogenic to turkeys are destroyed at these temperatures without impairing nutritive values of the cow manure.

1944-1002
HAMMOND, John C.
Dried Cow Manure and Dried Rumen Contents as a Partial Substitute for Alfalfa Leaf Meal
Poultry Sci. 23: 471-476

"It has become increasingly evident to the writer, that, because of the shortages of high grade alfalfa leaf meal and fish meal, cow manure or dried rumen contents may assume considerable practical importance in poultry feeding." Experiments are reported, with data tabulated, showing its importance in weight gains and efficiency. Such diets should be supplemented with vitamin A and riboflavin.

1945-1001
KRIEL, H. T.
The Use of Karoo Manure
Farming in South Africa 20: 87-88

Karoo manure tends to produce a brak [alkali] soil which expands when irrigated and shrinks, forming cracks, when dry. In a period of fertilizer shortage, it may be better than no fertilizer. If used, it should be restricted to well-drained sandy soils and to plants tolerant of alkali and salt. It is safe for most vegetables, but it should not be used on beans, peas, or trees.

1946-1001
BALLU, Tony
Sur l'utilisation du gaz de fumier en motoculture (On the Utilization of Manure Gas in Mechanized Agriculture)
Acad. Agr. France Comptes Rendus 32: 298-301

Production of methane from manure has been reported to be more successful in Algeria than in Metropolitan France. BALLU describes some poor practices he has observed and indicates corrective procedures in operation and design. He lists successful French applications including a 10 - 20 horsepower tractor which, he estimates, will be amortized in five years by savings in fuel costs. Prototypes should be less expensive than the pilot model.

1946-1002
BIRD, H. R.; RUBIN, Max; WHITSON, Donald; and HAYNES, S. K.
Effectiveness of Dietary Supplements in Increasing Hatchability of Eggs and Viability of Progeny of Hens Fed a Diet Containing a High Level of Soybean Oil Meal
Poultry Sci. 25: 285-293

In tests at Beltsville, a soybean oil meal diet was found to be correctible by the inclusion of five percent cow (or steer) manure, ten percent sardine meal, or ten percent dried skimmilk. With these supplements hatchability increased to 82, 78, and 79 percent, respectively.

1946-1003
PETTET, A. E. J. and JONES, E. E.
Waste Waters from Farm Premises
Inst. Sew. Purif. Jnl. and Proc. 45, II: 190-194

With the extension of piped water to rural regions in England, consideration is being given to reducing the pollution potential from cowshed washdowns by including the washings in the inflow to sewage treatment plants. Data obtained from studies at two agricultural research stations in Berkshire are tabulated. It was concluded that methods of operation were more significant than number of cattle in estimating polluting load.

1946-1004
RUBIN, Max and BIRD, H. R.
A Chick Growth Factor in Cow Manure. I. Its Non-Identity with Chick Growth Factors Previously Described. II. The Preparation of Concentrates and the Properties of the Factor.
Jnl. Biol. Chem. 163: 387-400

Cow manure contains a factor shown by a series of experiments described in the paper to be something other than the vitamins or other factors previously reported. It is the only such factor which has improved the growth-promoting properties of the basal diet.

The factor is soluble in water or ethyl alcohol and may be extracted for supplementing rations. Hens fed dried cow manure or fish-meal transmitted enough of the substance to their chicks to permit them to grow well on the basal diet.

1946-1005
RUBIN, Max; BIRD, H. R.; and ROTHCHILD, Irving
A Growth Promoting Factor for Chicks in the Feces of Hens
Poultry Sci. 25: 526-528

Cow manure and urine-free hen feces contain a growth factor, apparently synthesized in the digestive system since it appears even when lacking in the hen's diet, which is neither protein nor chemically-characterized vitamins. When corn was replaced by an equal weight of manure, the following results were obtained for the average weights of chickens at six weeks (grams): control 359.5, 5 percent cow manure 450.8, and 5 percent urine-free hen feces 451.8.

1946-1006
WHITSON, D.; TITUS, H. W.; and BIRD, H. R.
The Effect of Feeding Cow Manure on Egg Production and Hatchability
Poultry Sci. 25: 143-147

In feeding tests at Beltsville, the addition of 8 percent of cow manure, dried for 24 to 48 hours at 45°C, to an all-mash ration seriously impaired egg production in a 48-week test. When, however, the cow manure was dried at 80°C for 24 hours, an 8 percent inclusion had no effect on egg production. Hatchability was good in both programs. There was no effect on body weight or egg size. It was concluded that the higher temperature destroyed the androgenic potency of the manure without diminishing the growth-promotion effect.

1947-1001
GROSCHKE, A. C.; RUBIN, Max; and BIRD, H. R.
Seasonal Variation in Hatchability and Its Relation to the Unidentified Dietary Factor in Cow Manure (Abst)
Poultry Sci. 26:541

In a series of tests with hens on a corn-soy bean oil meal diet hatchability was seasonal. Upon addition of the unidentified factor of cow manure to the diet, hatchability increased and lost its seasonal character.

1947-1002
RUBIN, Max and BIRD, H. R.
A Chick Growth Factor in Cow Manure. III. Its Occurrence in Eggs.
Poultry Sci. 26: 309-310

The growth factor discussed in earlier papers is transmitted by hens to eggs and, hence, to chicks. Confirmatory tests are reported.

1947-1003
RUBIN, Max and BIRD, H. R.
A Chick Growth Factor in Cow Manure. IV. Methods of Drying Manure.
Poultry Sci. 26: 439-441

Sun-dried cow manure and pasture-dried cow chips were compared with oven-dried cow manure as ingredients in chick feed. The sun-dried manure was essentially equivalent and the pasture-dried chips were somewhat inferior in that they stimulated less body and comb growth.

1947-1004
TURNER, C. W.
Dried Lactating Cow Manure in the Ration of Growing Chickens
Poultry Sci. 26: 143-149

Growth of cockerels was stimulated by substitution of cow feces dried for 24 hours at 45°C for alfalfa meal in a ration in amounts up to ten percent of the ration. Above ten percent, growth was depressed. Growth of pullets on all levels of cow manure tested (2-1/2, 5, 10, and 20 percent) exceeded that of the controls.

1948-1001
BIRD, H. R.; MARSDEN, S. J.; and KELLOGG, W. L.

Supplements for Soybean Meal in Turkey Diets
Poultry Sci. 27: 53-59

"Five percent of dried cow manure proved to be an effective supplement in the 2 cases in which it was tried. . . The young turkey has a critical need for the unknown dietary factor which occurs in cow manure, in fish meal and probably in smaller quantities in meat meal."

1948-1002
GROSCHKE, A. C.; RUBIN, Max; and BIRD, H. R.
Seasonal Variation in Hatchability and Its Relation to an Unidentified Dietary Factor
Poultry Sci. 27: 302-307

Tests with groups of laying hens on a corn-soybean meal diet showed seasonal variation of hatchability when the hens were confined in open-front houses. The addition to the diet of the unidentified dietary factor of cow manure improved hatchability and eliminated its seasonal variation. "It is believed that the improved hatchability of the low hatching group was due to coprophagy, conditions being more favorable for the synthesis of the essential dietary factor in the voided feces during the warmer than during the cooler portions of the year."

1948-1003
KENNARD, D. C.; BETHKE, R. M.; and CHAMBERLIN, V. D.
Built-Up Floor Litter as a Source of Dietary Factors Essential for Hatchability of Chicken Eggs
Poultry Sci. 27: 477-481

The riboflavin content of chicken feces at the time of voiding is essentially that of the chickens' feed. The content will increase by 100 percent in feces kept at room temperature for 24 hours and by 300 percent in those kept a week. Thus bacterial action is indicated. Built-up floor litter serves as a potent source of supplementary dietary factors for chickens.

1948-1004
LILLIE, Robert J.; DENTON, Charles A.; and BIRD, H. R.
Relation of Vitamin B_{12} to the Growth Factor Present in Cow Manure
Jnl. Biol. Chem. 176: 1477-1478

Tests would indicate that vitamin B_{12} and the extract from cow manure reported by RUBIN and BIRD [1946-1004] are closely related if not identical.

1948-1005
ORCHARD, E. R. and LUDORF, R.
The Composition and Use of Karoo Manure. II. Value of Karoo Manure
as a Source of Plantfood
Farming in South Africa 23: 317-323

Prices in South Africa of Karoo manure and other fertilizers are tabulated for 1939, 1941, and 1946. For crops and soils for which it is suitable, crude Karoo manure may be the best buy in fertilizer. On the basis of equal dry weights, Karoo manure is preferable to either farm or municipal compost in fertilizer value.

"In the United States, sheep manure is no longer available for sale in significant quantities and the price has risen to such an extent that it is to-day by far the most expensive form in which nitrogen and phosphate can be bought. In Texas, the cost per lb of N and P_2O_5 in 1945 was 9.0 and 5.80 cents when bought as ammonium nitrate and superphosphate respectively, but in the form of sheep manure the cost per lb was 68 cents for nitrogen and 36.5 cents for P_2O_5, so that the price of the manure is prohibitive for ordinary farming purposes."

1949-1001
DYMOND, G. C.
The Water-Hyacinth: A Cinderella of the Plant World
Appx B of VAN VUREN: Soil Fertility and Sewage
Faber and Faber, London. p. 221-227 + pl

The subheading, "Its use in sewage effluents, as a trapper of salts and a water purifier," indicates the importance attached to this rapidly growing weed considered primarily to be a menace to navigation. The author cites its high efficiency in removing nutrients and considers it to be especially suitable for effluent lakes. An acre will produce 1100 tons of plant per year, of which 66 tons is dry matter. Cropping is simple. Use as a compost is suggested.

1949-1002
JEWITT, T. N. and BARLOW, H. W. B.
Animal Excreta in the Sudan Gezira
Empire Jnl. of Exptl. Agr. 17: 1-17

In the Sudan Gezira the rainfall varies from 100 mm to 500 mm. The soil is cracking clay low in nitrogen. The paper reports studies of the value of dung from sheep, goats, a dry cow, and a tillage bull in supplying nitrogen. Such value was found to be highly dependent upon the feed. Urine, rather than dung, is high in nitrogen. "Animal manure finds a secondary use as fuel, and convenient accumulations are frequently burnt. The practice is readily understandable, for fuel is in very short supply in the irrigated Gezira. . . Values of 6,050, 6,920, and 6,550 B.T.U. have been determined on three samples of dung. The existence of this alternative use of dry dung and the system of uncontrolled grazing makes it unlikely that any measure of dung collection for manure could be instituted. . ."

1949-1003
SLINGER, S. J.; HILL, D. C.; GARTLEY, K. M.; and BRANION, H. D.
Soybean Oil Meal and Sunflower Seed Oil Meal in Rations for Broad-Breasted Bronze Turkeys
Poultry Sci. 28: 534-540

Supplements of 5 percent dried cow manure were found to be effective when fed with soybean oil meal.

1949-1004
VAN VUREN, J. P. J.
Soil Fertility and Sewage
Faber and Faber, London. 236 p. + pl

VAN VUREN, a South African who bases much of his philosophy on observations on the veld, advocates salvage of the fertilizer value of sewage and animal wastes (p. 149-165) by composting and spreading.

Karoo manure, the droppings of sheep and goats which had been confined nightly in the same kraals (pens) for periods of up to a century, is hauled by rail and sold for up to 50 shillings per ton. Guano, collected from 17 islands in the Atlantic with a total area of 400 acres, is sold only to bona fide farmers for use on specific crops. The 6000 to 9000 tons harvested per year sells for £ 10 per ton. "South Africa could easily use ten times the available quantity." Bat guano, of an inferior quality, sells for up to £ 6 per ton.

Methods of preserving barnyard manure to maximize its fertilizing value are discussed.

An appendix, "The Water-Hyacinth: A Cinderella of the Plant World," by G. C. DYMOND is abstracted separately [1949-1001].

1951-1001
FERAUD, M.
Le Gaz de Fumier [Manure Gas]
Acad. Agr. France Comptes Rendus 37: 175-180

French energy production in 1938 was (in trillions of calories): 70 from coal, 63 from petroleum, 17 from wood, and 80 by hydroelectric generation. Manure production of 70 to 80 million tonnes could have provided 30 trillion calories. The means of separating methane are described, costs are estimated, and uses suggested. Some 500 to 600 small plants exist in France.

In a discussion A. DEMOLON observed that the fertilizer value remains after the methane is extracted. He called for an intense thermo-chemical evaluation before launching a methane-oriented program.

1951-1002
PALAFOX, A. L. and ROSENBERG, M. M.
Dried Cow Manure as a Supplement in a Layer and Breeder Ration
Poultry Sci. 30: 136-142

Tests were conducted in the feeding of cow manure which had been dehydrated at a temperature below 158°F in an electric oven as 0, 5, 10, and 15 percent of the total mash intake. Similar tests were run with cow manure sun-dried in the open air. At the 5 and 10 percent levels both oven-dried and air-dried manure satisfactorily supported egg production, egg weight, body weight, hatchability, and feed consumption. The 15 percent ration of air-dried cattle manure, when supplemented with herring meal, supported all items except body weight in the previous list. The 15 percent ration of oven-dried manure, without the herring meal supplement, depressed egg production after twelve weeks but did not significantly affect body weight. A list of 22 references is included.

1951-1003
SQUIBB, R. L. and SALAZAR, E.
Value of Corozo Palm Nut and Sesame Oil Meals, Bananas, A.P.F. and Cow Manure in Rations for Growing and Fattening Pigs
Jnl. Animal Sci. 10: 545-550

The pigs failed to benefit significantly from the cow manure supplement to the rations. "The lots fed the cow manure were unthrifty and lacked uniformity. . . The pigs fed cow manure ate the rations readily and consumed as much feed as did the other lots." A.P.F. is animal protein factor.

1952-1001
CHEVALIER, Gaston and LONCHAMBON, Raymonde
Sur les fumiers et purins dérivés du gas de fumier (On the Manures and Liquid Manures Derived from Manure Gas)
Acad. Agr. France Comptes Rendus 38:199-203

A battery of eight digesters in Algeria with a total capacity of 300 cu m have furnished power and heat for a school for two years.

The digesters are supplied, in turn, with the manure from 15 cattle, 12 horses, and 25 hogs -- an annual total of some 260 tonnes, 50 percent dry matter. The residue has a water content some 3 to 8 percent greater than the manure. Chemical analyses are tabulated. The residue has a fertilizing value superior to that of manure.

1952-1002
COMBS, G. F.
Algae (Chlorella) as a Source of Nutrients for the Chick
Science 116: 453-454

"The inclusion of 10% Chlorella to the basal diet in place of an equal amount of soybean meal resulted in a very marked increase in growth and improvement in feed efficiency. This improvement is attributed primarily to the high riboflavin and carotene content of the Chlorella. . ." Chicks fed Chlorella developed beak deformities. It is thought that methods of processing exist which will avoid this development. No other ill effects were evident. Costs must be evaluated yet.

1952-1003
PALAFOX, A. L. and ROSENBERG, M. M.
Further Studies on the Effect of Dried Cow Manure on the Domestic Fowl
Poultry Sci. 31: 673-678

In a series of tests designed to resolve the discrepancies between the results reported by WHITSON et al [1946-1006] and PALAFOX and ROSENBERG [1951-1002] on the possible detrimental effects of including more than eight percent oven-dried cow manure in the ration, the authors failed to verify WHITSON'S results and fed fifteen percent manure without significant effect on egg production.

1954-1001
ELAM, J. F.; JACOBS, R. L.; and COUCH, J. R.
Unidentified Factor Found in Autoclaved Litter (Abst)
Poultry Sci. 33: 1053-1054

Chicken growth increased when eight ml of a filtered suspension of litter, unchanged for three months prior to collection, autoclaved 15 min at 15 psi and 121-125°C was added to each pound of feed. By adding both fish solubles and litter solubles, growth was further increased.

1954-1002
JACOBS, R. L.; ELAM, J. F.; FOWLER, Jean; and COUCH, J. R.

An Unidentified Chick-Growth Factor Found in Litter
Jnl. of Nutr. 54: 417-426

A chick-growth factor, present in litter, is reported which gave a significant growth reponse when added to an all-vegetable protein diet adequate with respect to all known vitamins. "It is concluded that the litter factor is not an antibiotic and differs from the growth factor present in fish solubles."

1954-1003
KENNARD, D. C.; MOORE, Earl N.; and CHAMBERLIN, V. D.
The Role of Floor Litter Management in Nutrition and Disease Prevention of Chickens (Abst)
Poultry Sci. 33: 1063-1064

Chickens fed the same all-plant diet with added riboflavin had good hatchability (85 percent) of fertile eggs when on old compost litter, but only 51 percent when on fresh litter. "The compost litter provided adequate vitamin B_{12} for maximum hatchability of eggs." Disease losses during the first twelve weeks were 14 percent on fresh litter and 7 percent on compost litter. "Of 12 consecutive broods, each of 200 chicks, raised on the same compost litter in continuous use for five years, the disease loss averaged 5.7 percent versus 10.8 percent of corresponding broods started on fresh litter."

1955-1001
NOLAND, Paul R.; FORD, B. F.; and RAY, Maurice L.
The Use of Ground Chicken Litter as a Source of Nitrogen for Gestating-Lactating Ewes and Fattening Steers
Jnl. Animal Sci. 14: 860-865

"Feeding trials were conducted with both gestating-lactating ewes and fattening steers in which ground chicken litter was used to replace conventional protein concentrates. In the ewe trial the group fed ground chicken litter performed as well as those fed soybean meal. Both of these feeds produced results superior to ammoniated molasses when fed as a source of supplemental nitrogen. Fattening steers fed ground chicken litter did not gain as rapidly as those fed cottonseed meal when both groups were pair-fed for equal feed intake. By increasing the total feed intake of the chicken-litter-fed steers by 15 percent the rates of gain nearly equalled those fed cottonseed meal. No digestive disturbances or excessive feed refusals were noted in either of the two feeding trials."

1956-1001
DAVIS, "Dude"
Feeding Poultry Litter
Poultry Tribune 62: Aug. p. 10

Poultry litter is reportedly being fed to beef cattle throughout the South. Hogs and dairy cattle also do well on it. Feeding costs have been cut as much as 60 percent. "No trouble has shown up -- except in breeding animals." Drugs in the litter have been responsible for some stillbirths.

1956-1002
HANCOCK, Randolph S.
His Broilers Thrive on Worm Compost
Farm Jnl. Apr.
Reprint: Poultry Digest 15: 272

Worms raised on a ration of peat moss, commercial laying mash, corn meal, and a small amount of molasses produce a compost by adding their excrement. Broilers raised on the compost reached 3-1/2 lb weight in eight weeks. The other half of the same flock, raised on regular commercial broiler feed, required ten weeks to reach 3 lb. Vitamin B_{12}, antibiotics, and minerals are assumed to be the explanation.

1956-1003
ANON [Based on Arthur A.CAMP]
More About Cattle Eating Poultry Litter
Alabama Poultry Industries, May-Jun-July
Reprint: Poultry Digest 15: 504

CAMP, superintendent of the Gonzales Ag. Expt. Station in Texas, states that "a mixture containing litter makes a complete ration for cattle. It's not a distress feed but a year-round good feed." It is prepared by adding 40 percent litter based on peanut hulls or cane pulp to 38 percent milo, 10 percent alfalfa leaf meal, 10 percent molasses, and two percent mineral mix (bone meal and salt) in a concrete mixer. The non-litter portion of the ration costs $1.45 per 100 lb.

1957-1001
GRAU, C. R. and KLEIN, N. W.
Sewage-Grown Algae as a Feedstuff for Chicks
Poultry Sci. 36: 1046-1051

Dried unicellular algae contains 40 percent or more protein and significant amounts of carotenoids. It may effectively supplement cereal grains which are relatively low in protein. "The chick can tolerate diets containing up to 20% aluminum-free algae meal. The presence of significant amounts of aluminum in the meal resulting from alum-flocculation harvesting procedures depresses chick growth."

1957-1002
WINTERS, P. C.
The Production of Methane Gas from Farm Manure and Wastes
Power Farming and Better Farming Digest. Sept. p. 29-31, 33, 35

WINTERS, a South African farmer, discusses the design and construction of his plant which successfully produces sufficient methane gas to operate his farm. Temperatures are critical in the functioning of methane-producing bacteria. At their optimum temperature, 86°F, they can compost cattle manure in 21 days. Up to five months may be required at lower temperatures with no significant activity occurring below 60°F. Pig manure is twice as productive of methane as is cattle manure.

1958-1001
HANSEN, C. M.
Engineering Principles in Handling Liquid Materials
Agr. Engrg. 39: 546-551

Use of liquid manure declined because of back-breaking labor and inefficiencies inherent in separate handling of urine and feces. Dilution of total waste followed by pumping for irrigation, as done in Germany, would be unacceptable here. "Perhaps the crux in the handling of liquid manure is the type of pump required to move the manure from one area to another."

Questions to be answered by an operator contemplating use of liquid manure include those on economics, effect on milk and meat production, optimum amount of water, time requirements for handling stock, freezing weather, labor, and structural design.

1958-1002
KROONTJE, Wybe; GISH, P. T.; and STIVERS, R. K.
Nutrient Value of Poultry Manure Compared with that of Mineral Fertilizer
Virginia Ag. Ex. Sta. Bull. 498 12 p.

To be as effective as commercial fertilizers poultry manure must be reinforced with additional P_2O_5 and K_2O.

1958-1003
SOUTHWELL, B. L.; HALE, O. M.; and McCORMICK, W. C.
Poultry House Litter as a Protein Supplement in Steer Fattening Rations
Georgia Ag. Ex. Sta. Mimeo Series NS55 6 p.

Three groups of steers were fed equi-protein rations containing 30 percent, 15 percent, and 0 percent poultry house litter based on corn cobs on which two batches of broilers had been raised. The top four to five inches of corn cobs, which contained virtually all the manure, were run through a hammermill and mixed in the feed. There was little difference in average daily gain. Costs per pound of gain were 21.4 ¢ with 30 percent litter, and 20.1 ¢ with 15 percent or 0 percent litter. Because of wide variability, a chemical test should be run on each large batch of litter. Peanut hulls or wood shavings would be almost worthless as a litter to be fed.

Data, including costs, are tabulated.

1959-1001
BARNES, R. H.; FIALA, Grace; DELANEY, K.; and CAPLAN, E.
Coprophagy, Refection and the Influence of Antibiotics in the Rat (Abst)
Federation Proc. 18: 516

A poorly-understood phenomenon is that after feeding certain chemicals, such as dextrin, which inhibit growth in rats, the addition of penicillin will cause a marked increase in growth rate -- unless coprophagy is prevented. The antibiotic alone is ineffective in producing growth; it must be accompanied by ingestion of feces.

1959-1002
BURNS, Edward C.; TOWER, B. A.; BONNER, F. L.; and AUSTIN, H. C.
Feeding Polybor 3 for Fly Control under Caged Layers
Jnl. Econ. Ent. 52: 446-448

Polybor 3 was fed to caged layers five months at 0.05, 0.10, 0.20, 0.30, and 0.50 percent of the ration. Effective larval control of the house fly was obtained at the higher rates of feeding, but boron residues were found in both eggs and tissues at all levels. Boron compounds are classed as poisonous and deleterious substances by the U. S. Food and Drug Administration.

1959-1003
CAMP, Arthur A.
Broiler House Litter a Feeding Trial Subject
The Feed Bag 35: Sept. p. 68

Successful feeding of untreated litter at various rates to cattle and swine is reported. The litter tested was peanut hulls or cane. The protein value increased with time in service. It is about 21 to 22 percent for once-used litter and may reach 33 percent for litter on which nine runs are produced. Rocks, nails, and glass should be avoided in litter to be used as feed.

1959-1004
FENNER, H. and ARCHIBALD, J. G.
A Critical Study of Energy Determination in Fresh and Dried Cow Feces
Jnl. Dairy Sci. 42: 1995-2001

"An accurate method of determining energy in fresh feces is described in detail." The difference in energy content as determined from freeze-dried, oven-dried, and fresh feces being less than two percent, approximations by substitution of a dried form are often acceptable. Twenty-four references are cited.

1959-1005
JEDELE, D. G.
Liquid Manure for Midwest Swine Production
ASAE Trans. 2(1): 9-10
Abst: McQ & B B-001; W72-00979

Swine manure may be collected in storage tanks, pumped into tank-wagon spreaders, and distributed on crop land. Preliminary calculations indicate that the practice may be profitable on Illinois swine farms. The pens should be covered to exclude precipitation. The floors should be scraped first to hold use of water to a minimum. Collection tanks should be covered and should have a minimum capacity of one week's manure. At least two gal per hog per day will accumulate. Spray irrigation after piping to the field is an alternative used in Britain.

1959-1006
KLIPPLE, G. E. and RETZER, John L.
Response of Native Vegetation of the Central Great Plains to Applications of Corral Manure and Commercial Fertilizer
Jnl. of Range Mgmt. 12: 239-243
Abst: McQ & B B-393

Results of tests in Colorado, Saskatchewan, and North Dakota showed that native vegetation in the Great Plains may be improved by applications of manure. Commercial fertilizers proved to be less effective.

1959-1007
PARKER, M. B.; PERKINS, H. F.; and FULLER, Henry L.
Nitrogen, Phosphorus and Potassium Content of Poultry Manure and Some Factors Influencing Its Composition

Poultry Sci. 38: 1154-1158
Abst: McQ & B B-245

"Research to determine the value of broiler manure has not kept pace with its production." Conflicting analyses are cited. Varying management practices, housing constructions, and climate can be expected to affect values found. For broiler manure the authors found: moisture 24.9 percent, N 2.27 percent, P 1.07 percent, and K 1.70 percent (total basis). For hens the percentages were 36.92, 2.00, 1.91, and 1.88, respectively.

1959-1008
RAY, Maurice L.
Effects of Methods of Preparation of Chicken Litter on its Utilization by Beef Cattle (Abst)
Jnl. Animal Sci. 18: 1150

Steers fed ground litter which was dusty ate sparingly and lost an average of 40 lb on a 27-day test. When the litter was pelleted, intake and gains improved for the cattle fed oat straw litter, but not for those fed cane bagasse litter. "Two lb of black strap molasses fed daily on top of the other feed did not improve intakes or gains."

1959-1009
RODRIGUEZ, J. L., Jr. and RIEHL, L. A.
Results with Cockerels for House Fly Control in Poultry Droppings
Jnl. Econ. Entom. 52: 542-543

Cockerels confined under caged hens in a ratio of one cockerel to ten hens solved the fly problem by eating all larvae. The cockerels were fed at dusk and thus had a good appetite during hunting hours.

1959-1010
ZANEVELD, Jacques S.
The Utilization of Marine Algae in Tropical South and East Asia
Economic Botany 13: 89-131

This paper, with its 161 references to which the text is keyed, surveys the various genera of marine algae of tropical south and east Asia and cites uses, usually as human food, to which they are put.

1960-1001
COOPER, J. B.; MAXWELL, T. L., Jr.; and OWENS, A. D.
A Study of the Passage of Weed Seeds Through the Digestive Tract of the Chicken
Poultry Sci. 39: 161-163

A literature search (six references given) indicated that most weed seeds do not survive passage through a chicken. A few, however, may actually have their germination potential improved. For 25 varieties tested at Clemson, no seeds survived the passage. "The viability of the seeds was destroyed in the intestinal tract."

1960-1002
HART, S. A.
The Management of Livestock Manure
ASAE Trans. 3(2): 78-80
Abst: McQ & B B-002

Manure will seldom show a profit. It must, however, be disposed of for considerations of animal health, wholesome food production, efficient operation, land improvement, aesthetics, and fly breeding. Materials-handling engineering is called for: gather, process, and dispose. Moisture content should be reduced to reduce weight and volume to be handled.

"Ultimate disposal of most manure will be onto farm land. The spreading of the manure onto the field may or may not be simple. Poultry ranches and dairies within urban areas usually have no land."

1960-1003
LaBRECQUE, G. C. and SMITH, Carroll N.
Tests with Young Poultry for the Control of House Fly Larvae Under Caged Laying Hens
Jnl. Econ. Entom. 53: 696
Abst: McQ & B B-560

Fly larvae develop immunity to larvicides. In tests in Florida in which one chick was given access to the droppings from ten caged hens, he cleared the pit of larvae in a week. In another test full control was established in five days and maintained two months (until winter). Supplementary feed and water are provided for the chicks. No mortality resulted.

1960-1004
OLDS, Jerome
Processing Poultry Manure for Fertilizer Use
Compost Sci. 1: Summer p. 24-27
Abst: McQ & B A-015

Poultry manure, "the richest in plant food value of any of the farm manures," is estimated to be worth an extra 1.5 ¢/lb on the selling price of broilers or an extra dozen eggs per year per layer. Composting and pelleting operations are described.

1960-1005
VERBEEK, W. A.
Fowl Manure Is a Valuable Cattle Feed
Farming in South Africa 36: June p. 21

Cattle, being able to convert non-protein nitrogen, can extract up to 25 percent of the nitrogen present in fowl manure as protein. Other nutrients and spilled feed in the manure are also valuable in cattle feed. Oxen on a test at Potchefstroom College found a ration containing 24 percent fowl manure as a supplement to mealie cobs unpalatable at first, but soon acquired a liking for it. Fowl manure may also be used with roughage to tide oxen over a winter. "The addition of about one pound of fowl manure to the winter rations of oxen will do much to prevent loss of weight."

1960-1006
WEHUNT, K. E.; FULLER, H. L.; and EDWARDS, H. M., Jr.
The Nutritional Value of Hydrolyzed Poultry Manure for Broiler
Chickens
Poultry Sci. 39: 1057-1063
Abst: McQ & B B-247

"Chicks can utilize a portion of the protein of hydrolyzed broiler litter when added to diets that are sub-optimal in protein. . . On the basis of crude protein, the manures were less efficient than either soybean oil meal or the casein-gelatin combination. . . Only about one-half of the crude protein of hen manure and slightly more than one-third of that of broiler manure exists as true protein." The presence of unidentified growth factors in litter renders it "nearly equal to a combination of fish solubles and dried distiller's solubles and superior to either alone in supplementing corn-soybean oil meal type rations containing no other recognized source of unidentified growth factors."

1961-1001
ANTHONY, Darrell W.; HOOVEN, Norman W.; and BODENSTEIN, Otelia
Toxicity to Face Fly and House Fly Larvae of Feces from Insecticide -
Fed Cattle
Jnl. Econ. Entom. 54: 406-408
Abst: McQ & B B-562

Results are reported of tests of dosages of various strengths of several insecticides included in cattle rations to kill larvae of face flies and house flies in their feces. Most treatments succeeded, but possible secondary effects must be investigated.

1961-1002
BURNS, Edward C.; WILSON, B. H.; and TOWER, B. A.
Effect of Feeding *Bacillus thuringiensis* to Caged Layers for Fly Control
Jnl. Econ. Entom. 54: 913-915

Flies develop resistance to insecticides. Thus other methods of fly control are of interest. Tests on several commercially prepared spore powders are reported in this paper. The results varied considerably and in some cases feed consumption and egg production suffered. ". . . there is a need for standardization and some method of assaying formulations for toxicity."

1961-1003
DANKENBRING, Ray
Is Manure Worth the Hauling?
Farm Jnl. 85: Mar p. 33, 61-62

A country-wide panel of experts, when polled, agreed that manure did not have enough fertilizer value ($2.05 to $10.38/ton on N, P, K content) to compete economically with commercial fertilizer. Costs of land spreading for disposal can, however, be made less of a burden by taking advantage of this value.

1961-1004
DOROUGH, H. W. and ARTHUR, B. W.
Toxicity of Several Organophosphates Administered in the Diet of Broilers to House Fly Larvae in the Feces
Jnl. Econ. Entom. 54: 1117-1121
Abst: McQ & B B-564

Direct application of insecticides being expensive and time-consuming, considerable development of larvicidal preparations to be fed to chickens for excretion has been reported (17 references). Tests with 14 of these at levels of 50, 100, 200, 400, and 800 ppm are tabulated and discussed. Unpalatability of the feed is probably responsible for the weight losses and chicken mortalities which occurred in some of the tests.

1961-1005
EDDY, Gaines W. and ROTH, A. R.
Toxicity to Fly Larvae of the Feces of Insecticide-Fed Cattle
Jnl. Econ. Entom. 54: 408-411
Abst: McQ & B B-563

Studies on the toxicity to newly-hatched house fly larvae of the feces of cattle fed 25 different compounds are reported. Eleven of the 25 were lethal to the larvae at dosages tested. Fly control by the feeding of insecticides is considered to be "not only possible but in the realm of practicability."

1961-1006
FREY, L. J.
Manure Smell Furnishes Farmstead's Power Needs: Gas Produced from Dung; Fertilizer Value Saved
Pig Farming Magazine [Great Britain]
Reprint: National Hog Farmer v. 6, Mar. p. 35-36 (1961)

The author describes a power plant he built in South Africa in 1958 in which an anaerobic digester produces sufficient methane gas from the dung of 700 pigs, about 1600 lb daily, to power the farm and three houses free of all fuel costs. The residue is a soupy black fluid with a slight ammonia odor which constitutes a fly-free, easily-spread fertilizer. "There is no better fertilizer than the natural one, and here it is in full strength, neither leached nor bleached, as it is in composting."

The digester is heated by running the cooling water piping from the high-compression engine through the digester. Methane is a clean, safe fuel which could be compressed for use in tractors, trucks, or cars. The cost of the compressor is such, however, that this would be uneconomical. Frey's system would work in any climate.

1961-1007
WARDEN, W. K. and SCHAIBLE, Phillip J.
The Effect of Feeding Antibiotics to Chicks in the Presence of Fresh, Dried and Autoclaved Hen Feces
Poultry Sci. 40: 363-367

A factor which depresses the growth of chicks occurs in fresh hen feces, but not in dried or autoclaved feces. It may, therefore, be a living organism or organisms rather than a toxic substance. Antibiotics improved performance in all cases.

1961-1008
YATES, J. D. and SCHAIBLE, P. J.
The Value of Virginiamycin and Certain Other Antibiotics in Chick and Poult Rations Contaminated with Raw or Heated Hen Feces (Abst)
Poultry Sci. 40: 1472

The antibiotics studied improved rate of growth and feed utilization when the feed was uncontaminated with feces. In general, the addition of fresh hen feces depressed growth. "Heated (100°C) fresh hen feces improved the growth rate of chicks which received no antibiotics and turkey poults which received virginiamycin in the ration."

1961-1009
ANON
Manure as Power Source to Heat, Light and Ventilate Hog Houses
Agr. Engrg. 42: 662

An unnamed Iowa State University agricultural engineer is testing the feasibility of employing the 4400 BTU/animal produced as methane gas.

1962-1001
ANTHONY, W. Brady and NIX, Ronald
Feeding Potential of Reclaimed Fecal Residue
Jnl. of Dairy Sci. 45: 1538-1539

"The objectives of this research were to (1) recover some of the fecal feed and (2) develop an effective means of disposing of organic residues voided by confined cattle."

Manure was collected daily from a concrete lot, diluted, stirred, and allowed to settle. Supernatant was poured off, water added, the mixture was stirred and allowed to settle for several cycles. The wet fecal residue (stored at 33°F until needed) was mixed with basal feed, 40 percent to 60 percent, and 1 lb of dried yeast was added for each 100 lb of feed. The mixture was stored twelve hours before feeding. Cattle enjoyed it and thrived on it.

1962-1002
CASTLE, M. E. and DRYSDALE, A. D.
Liquid Manure as a Grassland Fertilizer. I. The Response to Liquid
    Manure and to Dry Fertilizer
Jnl. Agric. Sci. 58: 165-171
Abst: McQ & B B-434

There was little difference in yield of herbage dry matter or in crude protein between various water treatments accorded to manure. Both wet and dry manure increases yield significantly. By the end of the third year the clover contents of the sward on liquid-manure, dry-fertilizer, and control were 32, 18, and 15 percent respectively.

1962-1003
EBY, Harry J.
Manure Lagoons . . . Design Criteria and Management
Agr. Engrg. 43: 698-701, 714, 715
Abst: McQ & B B-629

Manure lagoons are not a cure-all. They are not applicable where land is unavailable or too porous, where water is scarce, where danger of pollution of streams or groundwater exists, or where land is too expensive.

Loadings for municipal sewage lagoons are specified by state agencies. These may be modified for animal wastes.

The processes which cause a lagoon to operate are described and design criteria are proposed. Management problems result from floating bedding, litter, and feathers; overloading; intermittent loading; aquatic weeds; and sludge build-up.

1962-1004
GELDREICH, E. E.; BORDNER, R. H.; HUFF, C. B.; CLARK, H. F.; and
KABLER, P. W.
Type Distribution of Coliform Bacteria in the Feces of Warm-Blooded
Animals
WPCF Jnl. 34: 295-301
Abst: McQ & B B-062

"The coliform bacteria have long been used as an indicator of human fecal pollution in sanitary bacteriology." Difficulties arise in that there are other sources of coliform bacteria and that several tests (in series) are required to isolate those from different origins. Testing procedures are described.

1962-1005
HENDERSON, John M.
Agricultural Land Drainage and Stream Pollution
ASCE Proc. 88: SA 6, p. 61-74
Abst: McQ & B B-089

Ultimate disposal of animal waste, despite differing intermediate processes, is almost exclusively to land surfaces. Little study has been given to the amount of pollution carried to streams from this source. Animal populations tend, however, to build up closely adjacent to, and often upstream of, metropolitan areas and thus may make serious demands on the total oxygen content of streams.

A case study for the Potomac River Basin above Washington, D. C. is reported on.

1962-1006
HUTCHINSON, T. H.
Methane Farming in Kenya
Mother Earth, July
Reprinted: Compost Sci. 13: Nov-Dec, p. 30-31 (1972)

A farmer in Kenya with fifty acres in coffee and with several hundred head of cattle used the manure for producing methane and applied the residue from the methane plant as the sole fertilizer for the coffee. Yields more than doubled in ten years with the yield-curve rising rapidly when last reported.

1962-1007
JAWORSKI, Norbert A. and HICKEY, John L. S.
Cage and Kennel Wastewater
WPCF Jnl. 34: 40-43

Measurements of BOD in washwater from a cage washing room in which cages containing mice, rats, guinea pigs, hamsters and rabbits are washed once a month are reported. Bedding from the cages is incinerated once or twice weekly. Water for all except the final rinse is recycled. Final rinse water is from potable mains. When this drains to the recycling tanks, an equivalent volume flows to the sewer.

Dog pens are washed once daily after removing gross fecal matter. BOD is about three times that of domestic sewage.

1962-1008
OSWALD, William J.
The Coming Industry of Controlled Photosynthesis
Amer. Jnl. Pub. Health 52: 235-242

Organic wastes may be decomposed by aerobic bacteria whose oxygen supply is provided by algae. The algae may be harvested at short intervals to feed animals which, in turn, provide more organic waste. Studies are under way on the effect of the included bacteria on the health of the animals.

At Richmond, California, algae production can average about 30 tons per acre per yr (5 in Dec, 60 in July). This is 2 to 10 times the peak yield of commercial crops. The protein production of algae is 12 tons per acre per year, of soybeans (the best vegetative source) 1 ton per acre per year, and of farm animals 100 to 200 lb per acre per year.

1962-1009
RODRIGUEZ, J. L. and RIEHL, L. A.
Control of Flies in Manure of Chickens and Rabbits by Cockerels in Southern California
Jnl. Econ. Entom. 55: 473-477
Abst: McQ & B B-566

Field tests under a variety of conditions established the effectiveness of controlling flies in manure under cages by permitting cockerels to scratch for and eat the pupae and larvae. Management suggestions are given in the paper. The manure should be kept as dry as possible and feed spillage should be avoided. The number of larvae and/or pupae consumed per day increases from zero at one or two days old to 100 on the third day and 8250 in the 20th week. A 15-week-old cockerel will consume about 200 grams of flies per day; this is higher than the free-choice consumption of grain or mash. All cockerels seemed healthy on the diet.

1962-1010
WATERFALL, C. E.
Farm Drainage - Control of Farm Effluents
Effluent and Water Trtmt. Jnl. 2: 560-561

Legislation in the United Kingdom in 1961 had classified farmlands as industrial premises whether operated for profit or not and denied them access to sewers. The author recommends "Gülle farming" as practiced on the continent for some years. This consists of pumping diluted wastes, as a slurry, from a storage tank to the fields to fertilize and irrigate. Some concern is expressed at the loss of runoff to streams.

"Quite clearly in the interests of good husbandry farm wastes should be returned to the land."

1962-1011
WURTZ, A. G.
Some Problems Remaining in Algae Culturing
Symposium: Algae and Man. p. 120-137

Algal activity in the purification of wastes depends on having the correct species present in a polluting environment tolerable to them. Ideally, some preliminary decomposition of strong wastes should occur and the modified wastes should then flow, after being supplied with oxygen, to algae cultures for final purification. Such is the pattern of stream self-purification.

"There are many algae which are a nuisance in natural waters. Others are useless: Though they produce some oxygen during their life, they become dangerous after their death by the oxygen absorption they may suddenly occasion, and the production of mud by their mass development. Most, however, are useful, being at the beginning of life in the waters, as food for every kind of animals living in the waters."

1962-1012
ANON
Engineer Tries Drying Poultry Manure with Electroosmosis
Agr. Engrg. 43: 558

An unnamed Michigan State University agricultural engineer is investigating the feasibility of drying poultry manure by electroosmosis. If the idea proves practical, he has predicted a profit to poultrymen of $28 per 100 birds on the sale of dry manure as pelleted commercial fertilizer.

1962-1013
ANON
Disposal of Farm Effluent
Effluent and Water Trtmt. Jnl. 2: 512-513

Under an Act of Parliament in 1961, the consent of a River Board is required for a British farmer to continue discharge of farm wastes to a water course. "As farm manure cannot be marketed there is only one thing to do with it and that is put it back on the land. There are four main methods of doing this: land treatment, irrigation, transport, and storage." These are described briefly. The fertilizer value is estimated to be £ 6 per acre.

1963-1001
ANDRES, O.
Agriculture and Compost
Compost Sci. 4 (1): 41, 42, 44, 46

"Agriculture uses green manures, stable manure and bedding straw, as well as compost, exclusively for reasons of soil improvement. . . Therefore, in practice, composts are a means for soil improvement and not (for supplying) nutrient fertilizers." Compost and manure are done an injustice in being evaluated on the basis of immediate crop improvements.

"An active soil possesses great ability regarding self-purification."

1963-1002
BARNES, Richard H.; FIALA, Grace; and KWONG, Eva
Decreased Growth Rate Resulting from Prevention of Coprophagy
Federation Proc. 22: 125-128

Rats, when prevented from practicing coprophagy, develop a depression in growth rate of 15 to 25 percent in four weeks. "Growth stimulation is observed only when fecal pellets are ingested directly on extrusion from the anus." Nine micronutrients are listed as being supplied in significant quantities from the feces. "The rat has a voracious appetite for feces. Even though a diet complete in all known required nutrients is fed, the rat will recycle approximately 35 - 50% of his feces."

1963-1003
DAFT, F. S.; McDANIEL, E. G.; HERMAN, L. G.; ROMINE, N. K.; and
HEGNER, J. R.
Role of Coprophagy in Utilization of B Vitamins Synthesized by
Intestinal Bacteria
Federation Proc. 22: 129-133

Coprophagy appears to be essential to rats in the prevention of pantothenic acid deficiency. Acute deficiencies in pantothenic acid lead to cessation of growth, loss of weight, and death.

1963-1004
DRUMMOND, R. O.
Toxicity to House Flies and Horn Flies of Manure from Insecticide-Fed Cattle
Jnl. Econ. Entom. 56: 344-347
Abst: McQ & B B-569

Results of a series of tests on the effectiveness of various insecticides included in the ration of cattle are given. In general, house flies were more resistant than horn flies to the preparations and dosages tested.

1963-1005
GATES, Charles D.
Treatment of Long Island Duck Farm Wastes
WPCF Jnl. 35: 1569-1579
Abst: McQ & B B-066

Serious pollution of shell fish and recreation areas of Long Island was traceable to effluent from duck farms. By "dry farming" (reducing the quantity of water per duck to 10 gpd or less from the customary 25 to 75 gpd), use of lagoons for sedimentation, and chlorination of the lagoon effluent substantial improvement resulted. The removal of the lagoon sludge poses serious operational and inspection problems.

1963-1006
HART, Samuel A.
The Growing Problem of Poultry Waste Disposal
Agr. Engrg. 44: 430

This summary of a Symposium on Poultry Industry Waste Management held at the University of Nebraska, 13 - 15 May, 1963, pointed up many unsolved problems. Poultry manure cannot compete economically with chemical fertilizer. "While interest in lagoons was high, from workshop discussion it became apparent that knowledge on this disposal technique was meager."

1963-1007
HART, Samuel A.
Digestion Tests of Livestock Wastes
WPCF Jnl. 35: 748-757
Abst: McQ & B B-065; W71-05416

Sludge digestion as a means of stabilizing manure was studied at the University of California. In many ways, results are similar to those obtained with domestic sewage sludge. There are, however, differences. There is little benefit from, or need for, digestion of dairy manure. The digestion of chicken manure is feasible and desirable. Costs are reasonable. The digester for a 10,000-hen operation could have a diameter of 16 feet and height of 10 feet.

1963-1008
HART, Samuel A. and SCHLEUSENER, Paul E.
Rural Wastes and Agricultural Engineering
Agr. Engrg. 44: 142-143

Summarizing a symposium held at the 1962 ASAE winter meeting, the authors observed that manure is too moist for successful composting and that garbage is too dry, too low in nutrients, and too bulky to compost. "Mixing the two wastes gives an excellent compost which is useful as a soil conditioner and amendment. Certain economic problems must be solved before such a solution can become a practical reality."

1963-1009
HARTMAN, Roland C.
Composting Controls Flies (and Saves Money) at Poultry Ranch
Pacific Poultryman 69: Feb. p. 18
Reprint: Compost Sci. 4 (1): 26-28 (1963)

At a chicken ranch at San Marcos, California, manure, except for a dry 6-in layer at the bottom, is removed semi-annually and piled to complete composting. This requires four to five weeks. The chicken ration is controlled to secure a dry manure and ventilation is optimum. The ranch has completed three years of successful, profitable, composting. The general applicability elsewhere would require further testing.

1963-1010
ROHLF, John
New Way to Salvage Undigested Grain
Farm Jnl. 87: Apr. p. 64

W. B. ANTHONY, of Auburn University, in a 54-day test using a feed for steers 40 percent of which consisted of washed cattle feces and 60 percent of which was basal ration, produced gains of 3.39 lb/day using 6.43 lb of feed (dry basis) per lb of gain. The "washing machine" costs $8000 for a 2000-steer operation. Research continues to reduce the price.

1963-1011
SALTER, P. J. and WILLIAMS, J. B.
The Effect of Farmyard Manure on the Moisture Characteristic of a Sandy Loam Soil
Jnl. of Soil Sci. 14: 73-81
Abst: McQ & B B-133

The ease with which plants can extract water from a sandy loam soil may be increased significantly by a long-term program of annual applications of manure to the soil. In the experiments reported the available water capacity of the top six inches was increased 70 percent over a six-year period.

1963-1012
TAIGANIDES, E. Paul; BAUMANN, E. Robert; and HAZEN, Thamon E.
Sludge Digestion of Farm Animal Wastes
Compost Sci. 4(2): 26-28
Abst: McQ & B A-382

Controlled digestion of manure offers a safe and completely mechanized system of liquid manure treatment and disposal with the following advantages:

1. The organic content of the waste is reduced by 50 to 70 percent.
2. The waste is well stabilized and ready for final disposal in a lagoon or by field spreading for fertilizer.
3. The digested waste is a thick, free-flowing liquid without offensive odor.
4. Rodents and flies are not attracted to the end product.
5. The fertilizing constituents are preserved.
6. Combustible gases with commercial value result.

The disadvantages listed are:

1. The digester has a high capital cost.
2. A residue remains to be disposed of.
3. Daily supervision is required.
4. Care must be exercised to avoid explosions.

The only U. S. plant, built with war surplus equipment in Southern California, is described. Several plants are functioning in Germany.

1963-1013
WILEY, John S.
Utilization and Disposal of Poultry Manure
Purdue University, 18th Ann. Indust. Waste Conf.
Reprint: USPHS Bull. 1969, 14 p. (1970)

After discussing the fly problems associated with poultry production in Orange County, California, the author considers the general topic of composting. Poultry wastes are too wet, too fine-grained, and of improper carbon-to-nitrogen ratio for composting alone. By adding the proper amount of sawdust, however, the properties of the mixture are excellent. Composted manure may be stored without odor for land spreading when convenient.

1963-1014
ANON
Just How Effective are Lagoons?
Compost Sci. 4(3): 25-29

Lagoons for municipal and industrial treatment depend upon algae and aerobic bacteria. They are shallow and have a large area. They are inapplicable for animal wastes because of the size required (one acre per 1200 chickens or 50 hogs), the need for makeup water to compensate for seepage and evaporation, and the impossibility of getting a uniform mixture of diluted waste.

Farm lagoons, indoor or outdoor, are anaerobic. They should be primed with sludge from a municipal plant. Odor problems may develop. Aeration is of no help. The overflow is highly polluting.

A sealed anaerobic lagoon is a digester. It has a high capital cost, requires maintenance and supervision, and involves some risks of explosions. It can, however, produce methane gas utilizable for fuel or electricity and the residue is an odorless fertilizer.

An anaerobic lagoon with the supernatant flowing to an aerobic lagoon is an excellent combination.

1963-1015
ANON [Based on W. B. ANTHONY]
New Way to Salvage Undigested Grain
Farm. Jnl. 87: Apr. p. 64

"Steers on a high-grain ration will pass up to 35% of the dry matter they consume," ANTHONY is quoted as saying. "You can recover about 60% of that -- 4 to 6 lb per steer -- by washing down the floors and catching the manure in a sump." The "washing machine" for processing the manure would cost about $8000 for a 2000-steer operation and pay for itself in two months. Study continues on developing cheaper washers for smaller operations.

1964-1001
AL-TIMIMI, Ali A.; OWINGS, W. J.; and ADAMS, John L.
The Effects of Air and/or Heat on the Rate of Accumulation of Solids in Indoor Manure Digestion Tanks (Indoor Lagoons)
Poultry Sci. 43: 1051-1056
Abst: McQ & B B-252

A concrete pit with 16-in water depth under slat floors had shown an increase of 11.7 percent in dry matter after 16 mo. In studies to see if this rate could be reduced, special tanks were built, the temperature was varied, and artificial aeration was provided in controlled amounts. The water surface was maintained constant. Neither heat, air, nor any combination was effective in reducing the percentage of dry matter.

1964-1002
ANDERSON, John R.
The Behavior and Ecology of Various Flies Associated with Poultry Ranches in Northern California
Proc. 32nd Ann. Conf. Calif. Mosquito Control Assn. p. 30-34

Flies on poultry ranches have many natural enemies. Parasitic wasps, earwigs, beetles, and mites feed on fly eggs and/or larvae. Spiders and birds feed on adult flies and/or larvae. Fungi kill many flies. The larvae of the black garbage fly, *Ophyra leucostoma*, attack and feed on other fly larvae whenever the latter are present. "When contained with a superfluous number of prey they always killed many more per day than they could possibly eat. The beneficial result of this behavior is that the superfluous prey larvae killed by *Ophyra* are eaten by the remaining living prey species. House fly larvae, for example, in preference to other food in their developmental medium, are rapidly attracted to and devour members of their own kind which have been killed and left by *Ophyra* larvae. Insecticides should be used where only flies congregate rather than where their predators might be wiped out.

1964-1003
BHATTACHARYA, A. N. and FONTENOT, J. P.
Utilization of Poultry Litter Nitrogen by Sheep (Abst)
Jnl. Animal Sci. 23: 867-868

Litter based on peanut hulls was autoclaved at 240°F and 15 psi for 40 min. Its crude protein content was 32.6 percent, dry basis. When tested as an equi-protein replacement for 25, 50, and 100 percent of the soybean meal in the ration of sheep, it was found that "percent utilization of absorbed nitrogen tended to decrease with increasing levels of litter nitrogen."

1964-1004
BRUGMAN, H. H.; DICKEY, H. C.; PLUMMER, B. E.; and POULTON, B. R.
Nutritive Value of Poultry Litter
Jnl. Animal Sci. 23: 869 (Abst)
Abst: McQ & B B-198

The authors report on experiments at the University of Maine in which laying house poultry litter was fed to four Hereford bulls. "Poultry litter is high in protein, low in energy and vitamins A and D. The metal needs to be removed from the litter by passing it over magnets and through a hammer mill. The litter should be thoroughly mixed with a high-energy feed. Phosphorus needs to be added or the animals will chew wood."

1964-1005
CARMODY, Robert
Chicken Litter Cow Feed
Farm Qtrly. 19: Fall p. 52, 53, 93, 94

Maine beef raisers have been successful in feeding laying house litter which has been on the floor 12 - 14 months (23 percent protein) or broiler litter 10-weeks old (21 percent protein) in a ration consisting of 1500 lb litter, 500 lb energy feed (potato pulp, high-fat hominy, or ground corn), 10 lb dicalcium phosphate, 130 g vitamin A, and 10,000 units vitamin D. Salt is provided free choice. No known diseases are transmitted from chickens to cattle. The mixture is unpalatable when wet, it must be thoroughly mixed, the energy content must be maintained, and the litter must be checked by magnet for nails, staples, and other scrap iron then thoroughly ground in a hammer mill. On free choice, cows eat 25 to 28 lb litter mix and 5 to 6 lb hay per day at a feed cost of $17 per ton or less, including hauling.

1964-1006
FISH, H.

Pollution Prevention in Relation to Agricultural Effluents
Chem. Ind. 9:354
Extract: Effluent and Water Trtmt. Jnl. 4: 419-422

Under the Rivers (Prevention of Pollution) Act of 1961 the river boards of the UK were authorized to require permits for the disposal of agricultural effluent to streams. Enforcement is being achieved gradually with as little inconvenience to farmers as is practical.

1964-1007
HART, Samuel A.
Manure Management in Poultry Waste Disposal
Agr. Engrg. 45: 430
Abst: C & S 64-0364

This is a summary of the Second National Symposium on Poultry Industry Wastes, held at the University of Nebraska 19 - 20 May, 1964, under the co-sponsorship of the ASAE and the Poultry Science Association.

Manure management was the principal topic discussed. Anaerobic lagoons appear promising. Aerobic lagoons require too much land and too much water for general applicability.

[CONNOLLY and STAINBACK: Solid Wastes Management: Abstracts from the Literature - 1964 abstract 17 papers from this symposium in addition to abstracting the proceedings in toto.]

1964-1008
HART, Samuel A.
Thin Spreading of Slurried Manures
ASAE Trans. 7: 22-25, 28
Abst: C & S 64-0367; McQ & B B-003; W71-05425

HART set out to determine how thick a layer of slurry (10 to 20 percent solids) could be spread day after day, layer on layer, without producing fly breeding or other sanitary problems. A daily layer 1/8-inch thick seemed optimum for summer spreading at Davis, California. Modifications for different climates and different uses are discussed. On this basis, one acre of land would serve 230 cattle or 60,000 hens. Lagoons will accomodate 10,000 to 20,000 hens per acre. It is possible, but not practical, to spread the slurry by fire hose and nozzle from peripheral roads. Odors were frequent and intense. Twenty-one references are cited.

1964-1009
HART, Samuel A.
Sanitary Engineering in Agriculture
Compost Sci. 4(4): 11-15
Abst: C & S 64-0366; McQ & B A-381

"Manure management is very seriously limited by costs." The four steps of management are collection, processing, storing, and utilization or disposal. HART discusses each in turn. Lagoons may be effective. Return to the soil will remain the destiny of most manure.

1964-1010
LEWINGTON, Peter
Chicken Litter Good
Country Guide [Winnipeg] Nov. p. 12-13

Success has been reported in Maine in raising cattle on a ration of 1800 lb poultry litter; 200 lb of corn hominy, minerals and vitamins; and hay. The 13-percent protein ration costs $17 per ton. For sheep a ration of 1600 lb poultry litter and 400 lb of broken white bean waste (from a cannery) has been successful. Poultry litter is high in protein (14.38 percent to 32.66 percent in tests at the University of Maine) and fiber but low in energy, vitamins, and available phosphorus. "As most of the protein comes from bacteria, sterilization of the litter would obviously destroy any value the litter had as feed. . . Drug residues are no problem, due to dilution and dissipation. No broilers are currently fed drugs which could be harmful to cattle. . . According to spokesmen for Canada's Health of Animals Division, the feeding of poultry litter to livestock would not contravene any Canadian regulations."

1964-1011
LIVSHUTZ, A.
Aerobic Digestion (Composting) of Poultry Manure
World's Poultry Science Jnl. 20: 212-215
Abst: McQ & B B-315; W71-05427

Standard composting procedures can be improved by provision of forced aeration and by covering the windrows with plastic sheets. The aeration system can consist of portable pipe with tees and properly-sized holes. It can distribute air uniformly, continuously or intermittently as desired.

The sheets of plastic should have exhaust spaces left between them. They prevent top drying by sun and wind, and wetting by rain and snow. They prevent fly breeding and odors; they appear neat and tidy.

Proper composting for poultry manure is described and cost estimates are given.

1964-1012
McGAUHEY, P. H.
Processing, Converting and Utilizing Solid Wastes
Compost Sci. 5: Summer p. 8-14

The experiences of the Sanitary Engineering Research Laboratory of the University of California in the Solid Waste field extend back to its foundation in the early 1950's.

"Research on animal manures has been largely directed to processing for the purpose of removing its nuisance and fly breeding potential, rather than to its utilization. . .if animal manures are to be utilized it must be in commercial agriculture. . . From the standpoint of utilization alone, animal manures represent perhaps the least fruitful area for research in the solid wastes field. . ."

1964-1013
PALMER, Lane M.
What's New in Manure Disposal
Agr. Engrg. 45: 134-135
Abst: C & S 64-0379

Reporting on a seven-paper symposium at the 1963 Winter Meeting of the ASAE, PALMER observed that trends were to dry manure to reduce odor and fly problems or, preferably, to liquify it for ultimate disposal on crop land or to lagoons. "All the speakers agreed that lagoons, as a means of ultimate manure disposal, had been overrated and under-built." Large requirements in water and land and problems with the ultimate disposal of accumulated digested sludge were cited.

S. A. HART had reported on algae production in lagoons followed by harvesting and drying of the algae to be fed to livestock. It was not considered to be economic under present conditions.

1964-1014
PERKINS, H. F.; PARKER, M. B.; and WALKER, M. L.
Chicken Manure - Its Production, Composition, and Use as a Fertilizer
Georgia Ag. Ex. Sta. Bull. N. S. 123. 24 p.

Investigations at three experiment stations in Georgia indicated that broiler and hen manures were valuable sources of readily available plant nutrients. "The manures vary widely in composition as a result of type of bird, kind of feed consumed, climatic conditions, management of the poultry house, and system of handling the manure upon removal from the house."

Weed infestation increased following the application of chicken manure to Coastal bermudagrass. Otherwise, effects reported were favorable.

1964-1015
PRYOR, W. J. and CONNOR, J. K.
A Note on the Utilisation by Chickens of Energy from Faeces
Poultry Sci. 43: 833-834
Abst: McQ & B B-251; W71-03583

Chicken manure can have high energy and nitrogen contents. Measured values are tabulated for various rations fed. When a portion of the ration in a controlled experiment was faeces from chickens on a high-energy ration, 30 percent of the original metabolisable energy present was recovered in the second cycle.

1964-1016
RAY, Maurice L. and CHILD, R. D.
He's Doing Well on Broiler House Litter
Feed Bag 40: July p. 46-47

An experiment at the University of Arkansas of substituting litter with a rice-hull base for rice-hull roughage is reported. With a grain-to-roughage ratio of 3:1, the steers on hulls gained 2.70 lb/day, while those on litter gained 2.65. The carcass grade was better for the steers on hulls. Hay was added to the ration during the trial to prevent bloat. Animal fat added to counteract dust depressed feed intake and gain on both rations.

1964-1017
RAY, Maurice L. and CHILD, R. D.
How Broiler House Litter Shapes up as Roughage for Steers
Feed Bag 40: Dec. p. 24-25

Litter may be considered to be a high-nitrogen roughage. In a feeding test at the University of Arkansas, steers wintered on an 80 percent litter ration gained 0.63 lb/day at a cost of 18.4 ¢, while those on an 80 percent rice hull ration gained 0.60 lb/day at a cost of 24.8 ¢. Switching from animal fat to dried molasses part way through the experiment improved the performance of the steers on litter and reduced that of those on rice hulls.

1964-1018
REEDER, Norman
Hog Manure Too Valuable to Waste
Nation's Agric. 39: May p. 14-15
Abst: C & S 64-0387

The fertilizer and soil-conditioner value of hog manure induced an Indiana farmer to pump liquid manure from beneath a slotted-floor confinement house and spread it by means of a 1000-gal capacity honey wagon on cornland or meadow.

1964-1019
RILEY, Charles
De-watering Poultry Manure
Agriculture 71: 527-529
Abst: C & S 64-0388; McQ & B E-005

Normal industrial processes have not proved to be very effective in handling poultry muck. The problems would appear to be high capital costs of an effective dryer, difficulty of supplying the muck to the machine from the birds at a constant rate, and improbability of financial return.

1964-1020
SATTAR, Adbus
Fish Meal and Manure: Their Preparations and Uses
Agric. Pakistan 13(2)
Reprint: Compost Sci. 4(4): 30-31
Abst: C & S 64-0814

Mixtures of commercial fertilizers and manure have proven to give higher yields of crops than manure alone. The author concludes that the principal value of manure is in improving soil structure, aeration, nutrient status, organic matter content, and biological activities.

1964-1021
TAIGANIDES, E. P.: HAZEN, T. E.; BAUMANN, E. R.; and JOHNSON, H. P.
Properties and Pumping Characteristics of Hog Wastes
ASAE Trans. 7: 123-124, 127, 129
Abst: C & S 64-0398; McQ & B B-004

By handling manure as a liquid complete mechanization can be achieved with a reasonable investment. To obtain data on the properties, a series of tests was run at Iowa State University. A diaphragm pump with a 6-inch auger proved satsifactory.

1964-1022
THOMAS, Ralph
Waste Into Energy
Science News Letter 86: 282-283

High fuel savings to industry in using burnable wastes as fuels are reported. Several leading manufacturers of steam generating equipment have devoted years of research and development to the design of furnaces to handle waste fuels.

1964-1023
WILEY, John S.
A Report on Three Manure Composting Plants
Compost Sci. 5: Summer p. 15-16
Abst: C & S 64-0483; W71-05739

Composting at a Washington feedlot carrying 5500 steers and at two million-bird chicken operations in California is described.

The steer manure, mixed with meat packing wastes and blood, is piled in windrows and turned six times in six weeks. The compost is bagged and sold. The chicken ranches each use rotary drums. One blends the manure with an equal amount of sawdust, hay, rice hulls, or cotton gin trash to improve moisture content. The other, unsuccessful to date, is attempting to operate on straight manure.

1964-1024
ANON [Based on W. B. ANTHONY]
Feeding Potential of Reclaimed Fecal Residue
Compost Sci. 4(4): 32
Abst: C & S 64-0361

Confinement of animals, concentrated feeds, and specialization whereby the cattle operator no longer has swine to rework the cattle droppings, have resulted in waste of feed voided unused. W. B. ANTHONY, of Auburn University, is attempting to recover some of the fecal feed and develop an effective means of disposing of organic residues voided by confined cattle.

1964-1025
ANON [Based on Virgil L. KROPP]
Dried Manure Plants Flourish
Compost Sci. 5: Spring p. 31
Abst: C & S 64-0425

The Stockyards Fertilizer Company, Inc., of Fort Worth, Texas, is "dehydrating the manure and removing impurities to supply a specialty market, mainly lawns, gardens and flower beds." Shipments are to go to 36 states.

1964-1026
ANON
"Breakthrough" in Poultry Manure
Compost Sci. 5: Summer p. 30
Abst: C & S 64-0351

A British firm is reported to have developed a process for producing a dry sterile powder, useful as a natural organic fertilizer, from poultry droppings. Processing data are included.

1964-1027
ANON
Manure as Pullet Feed
Pennsylvania Farmer, 14 Mar.
Reprint: Poultry Digest 23: 269

Texas Tech experiments with substituting poultry manure for milo in pullet feeds indicated that as the fraction of the ration consisting of manure went from 10 percent, to 25 percent, to 40 percent, the gain for birds was 1.17 lb (control), 1.19 (on 10 percent), 1.24 (on 25 percent), and 1.27 (on 40 percent). Feed used per lb of gain on these rations was 4.50, 4.77, 5.64, and 6.04 lb, respectively. New trials will substitute manure for protein components, rather than energy components, of the ration.

1965-1001
AL-TIMIMI, Ali A.; OWINGS, W. J.; and ADAMS, John L.
The Effects of Volume and Surface Area on the Rate of Accumulation of Solids in Indoor Manure Digestion Tanks
Poultry Sci. 44: 112-115
Abst: Mc Q & B R-259; W71-03582

A volume of 3.5 cu ft/bird was found to be adequate in an indoor manure digestion tank under a hen house to permit of operation with biennial cleaning. Surface area is important in relation to evaporation. Overflow problems can arise if less than 128 sq in per bird is provided. No significant effects of volume on digestion rates were observed.

1965-1002
ANDERSON, John R.
A Preliminary Study of Integrated Fly Control on Northern California Poultry Ranches
Proc. 33rd Ann. Conf. Calif. Mosquito Control Assn. p. 42-44

". . . unlike fly larvae most of the natural enemies are associated with the exposed surface of droppings. The natural enemies are, therefore, more at risk from insecticides, flames and other fly control measures applied to the droppings than are the developing fly maggots." Manure removal can upset the natural control even more seriously than can insecticides. "New accumulations of fresh, wet droppings were considerably more conducive to housefly propagation than to repopulation by mites."

1965-1003
BHATTACHARYA, A. N. and FONTENOT, J. P.
Utilization of Different Levels of Poultry Litter Nitrogen by Sheep
Jnl. Animal Sci. 24: 1174-1178
Abst: McQ & B B-202

Rations designed to equalize crude protein, crude fiber, calcium, and phosphorus with dried peanut hull litter replacing 0, 25, 50, and 100 percent of the soybean protein nitrogen were fed to sheep. "The data presented indicate that poultry litter nitrogen can be utilized efficiently by ruminants, especially when the level of litter nitrogen does not exceed 50 percent of the total nitrogen intake. In important poultry producing areas, litter may represent an economical source of nitrogen for ruminants. Before using this nitrogen source, however, feeders will have to consider the possibility of drug and pesticide contamination."

1965-1004
BRADLEY, Melvin and RUSSELL, Walter
Poultry Litter as Cattle Feed: Research Reviewed, Recommendations Given
Feedstuffs 37: 20 Feb. p. 59-60

Research in Virginia, Texas, Georgia, and Arkansas is reviewed briefly. While no diseases or drug poisonings have been reported, the potential danger exists. Wire scraps or other metal should be removed by magnets. The legal status should be investigated at the time and place of feeding.

Litter is highly variable; each batch should be subjected to chemical analysis. Keep the nitrates below one percent. Feed only loose, dry, non-dusty litter. Rice hulls or other plant bases are better than sawdust or shavings. Avoid chemical residues, scrap metal, and glass. If potability is a problem, the addition of molasses may help. Add vitamin A.

1965-1005
BUNTING, A. H.
Effects of Organic Manures on Soils and Crops
Proc. Nutrition Soc. 24: 29-38
Abst: McQ & B B-664; W71-05740

The principal contribution of organic manures to crops is nitrogen. "Organic material is not essential for the growth of green plants." While decayed organic matter can improve soil texture, "an incompletely decomposed farmyard manure or compost can in fact diminish the supply of N to the crop because all its own N, and some soil N, is used by the micro-organisms which rot the straw."

1965-1006
CLARK, Charles E.
Hog Waste Disposal by Lagooning
ASCE Proc. 91: SA 6: 27-41
Disc: STOLTENBERG, David H. 92: SA 4: 78-80; McKINNEY, Ross E.
    92: SA 4: 80-81
Abst: C & S 65-0231; McQ & B B-090; W71-03578

CLARK reports on visits to hog raising facilities in Illinois about which complaints had been received. "Never were the complaints found to be unjustified." Land spreading creates nuisances and is uneconomical. Digestion is subject to process failure caused by antibiotic effects of hog feed, temperature changes, or shock loads. The gas produced has a low production rate and a low BTU value. Lagoons, when properly designed and maintained, work.

McKINNEY points out size limitations for lagoons which restrict their use to small or moderate operations. For a 10,000-hog-per-year project in Kansas, an aerobic activated sludge unit is being installed.

1965-1007
DIGGS, B. G.; BAKER, Bryan, Jr.; and JAMES, Frank
Value of Pig Feces in Swine Finishing Rations (Abst)
Jnl. Animal Sci. 24: 291
Abst: McQ & B B-200

In a 63-day trial with swine rations containing 0, 15, and 30 percent dried pig feces gains were 1.56, 1.71, and 1.53 lb/day, respectively. Feed intakes were 3.63, 3.62, and 4.65 lb/day, respectively. No undesirable flavor was detectable in the pork.

1965-1008
DRAKE, C. L.; McCLURE, W. H.; and FONTENOT, J. P.
Effects of Level and Kind of Broiler Litter for Fattening Steers
    (Abst)
Jnl. Animal Sci. 24: 879
Abst: McQ & B B-201

Rations containing 25 percent peanut hull litter, 25 percent wood shaving litter and a zero-litter control were fed to steers. Feed efficiency was highest for the peanut hull, and lowest for the control ration. Neither litter ration affected the meat taste adversely. Performance on 25 percent litter in a second test was better than on 40 percent litter.

1965-1009
HART, S. A. and GOLUEKE, C. G.
Producing Algae in Lagoons
ASAE Trans. 8: 122-123 [Paper 63-922]
Abst: McQ & B B-010

The production of algae for livestock feed is feasible only in a completely aerobic lagoon. The harvesting involves a series of three difficult steps: concentration, dewatering and final drying with costs of 1.3, 1, and 1.5 to 2 ¢/lb of dried algae. Thus, the cost is more than that of soybean meal. Algae ponds are sensitive to overloads. The supernatant from a digester would be acceptable; manure would not. The process is not currently economically feasible in the U. S., but could ultimately become so.

1965-1010
HART, S. A.; TAIGANIDES, E. P.; and EBY, H. J.
Waste Disposal . . . Pre-Eminent Challenge to Agricultural Engineers
Agr. Engrg. 46: 220-221
Abst: C & S 65-0233

This summary of a session at the 1964 Winter Meeting of the ASAE cited European practice which is, almost without exception, to conserve manures by applying them to croplands. In developing uses rather than disposals intensified research into coprophagy (feeding manure back to other animals), algae production, fish culture using manure-fertilized water, and use as a fuel source with conservation of phosphorus and potassium nutrients was urged.

1965-1011
HART, S. A. and TURNER, M. E.
Lagoons for Livestock Manure
WPCF Jnl. 37: 1578-1596
Abst: McQ & B B-068; W71-05429

This is a report of testing of eight pilot lagoons on the Davis campus of the University of Calilfornia over a two-year period. Five of the lagoons were used for chicken manure throughout. The other three were used for dairy cattle manure the first year and swine manure the second. Characteristics of the manure and test results are tabulated and discussed.

"Manures are not sewage, and are really not very similar to sewage solids."

The lagoons proved to be effective in stabilizing organic matter and in reducing fly problems. Biological sealing of the bottoms did not occur to any appreciable extent.

"Infiltration may well control whether a lagoon can be used for manure disposal. . . If infiltration does not control the existence of a lagoon, then odors will be the major factor which will control its loading rate." Lagoons should be designed on the basis of BOD per unit volume translated into lagoon volume per animal. Lagoons should be deep and the influent should be discharged near the bottom to encourage mixing with the digested sludge. Lagoons must be cleaned periodically to restore their volume. Expect no miracles.

1965-1012
JEFFREY, E. A.; BLACKMAN, W. C., Jr.; and RICKETTS, Ralph
Treatment of Livestock Waste -- A Laboratory Study
ASAE Trans. 8: 113-117, 126 [Paper 63-919]
Abst: McQ & B B-008, G-002; W71-05430

From laboratory studies of animal wastes the authors conclude that aerobic lagoons alone are economical only if the feeder happens to possess a large pond. Anaerobic lagoons require occasional cleaning and sludge disposal. Series of anaerobic followed by aerobic lagoons appear promising.

1965-1013
JOHNSON, Curtis A.
Disposal of Dairy Manure
ASAE Trans. 8: 110-112 [Paper 63-918]
Abst: McQ & B B-007; W71-05424

Liquid manure handling offers the greatest promise. An adaptation of the principle of septic tanks with utilization of the methane gas produced to heat the tanks and, thus, improve the operation is suggested. Low-power systems are adequate for manure handling with continuous flow. By reusing flushing water, volumes can be kept minimal. Construction details are discussed.

1965-1014
JOHNSON, Curtis A.
Liquid Handling of Poultry Manure
ASAE Trans. 8: 124-126 [Paper NA 64-501]
Abst: McQ & B B-011; W71-06450

A pilot plant for handling liquid poultry manure by means of a septic tank is described. Modifications were under way to utilize the methane gas produced to heat the tank. Virtues of the method include ease of handling of the manure, simple disposal of effluent and sludge to land, low power requirement, and little odor produced. The capital cost was about $1 per bird.

1965-1015
JOHNSON, Curtis A.
Liquid Handling Processes for Poultry Manure Utilization
Compost Sci. 5: Aut-Wint. p. 18-22
Abst: McQ & B A-416

Waste disposal from a 7000-bird operation in Massachusetts by means of a septic tank is described. Modifications under way will heat the tank with the methane gas it produces. Cost data are given. Other liquid handling processes are described and the author conjectures on piping slurry to a city treatment plant.

1965-1016
LEWINGTON, Peter
Manure Smells Sweet at $194.50 a Ton
Country Guide [Winnipeg] Sept. p. 27

Mac CUDDY of Strathroy, Ontario, dries turkey litter in a two-stage process and packages it in 40-lb bags which sell for $3.89. The litter, which is kept as dry as possible at all times, is pre-dried to 55-60 percent moisture in a covered shed with a paved floor, then finally dried to eight percent in a secret process on which a patent is pending. CUDDY is considering the production of mushroom compost also.

1965-1017
McKELL, C. M.; BROWN, V. W.; ADOLPH, R. H.; and BRANSON, R. L.
Chicken Manure as Rangeland Fertilizer
Calif. Agric. 19: June p. 6-7
Abst. McQ & B E-106

The market for chicken manure in San Diego County being over-supplied, a three-year testing program on the possibilities of fertilizing rangelands deficient in nitrogen and phosphorus was undertaken in 1962. Preliminary findings indicate that the manure may be spread on a year-round basis and that the forage has improved nutritional value and palatability.

1965-1018
OSTRANDER, Charles E.
Poultry Manure Disposal
ASAE Trans. 8: 105-106 [Paper 63-916]
Abst: McQ & B B-005

This survey of American practice found no single best-solution to poultry manure disposal. In the South and Southwest, fly control can create more problems than manure disposal.

Lagoons can be aerobic only if they have large areas -- 1000 to 1500 hens/acre of lagoon in the North and 2000 hens/acre in the South. Anaerobic lagoons have odor problems. Lagoons on porous soil may cause groundwater pollution, and lagoons subject to freezing may be ineffective. They require competent management. Liquid manure from lagoons should be spread on land.

Composting is restricted by lack of markets for the product. Dehydration is generally unsatisfactory due to odors and to difficulty of producing a uniform marketable product.

1965-1019
RUSSELL, John
Manure Odors Can Land You in Court!
Farm Jnl. 89: Aug. p. 19, 36-37

More people and more animals are the bases for more complaints. Court orders and costs of litigation have forced some farmers to shut down. Advice offered to livestock operators who can see suburbia approaching is, in addition to maintaining good housekeeping, to seek zoning of land restricted to agriculture then watch eternally for the granting of exceptions and variances. State licensing has proved effective in Kansas.

1965-1020
STERN, Eric W.; LOGIUDICE, Albert S.; and HEINEMANN, Heinz
Approach to Direct Gasification of Cellulosics
I & EC Process Design and Dvpt. 4: 171-173

The technical feasibility of direct conversion of cellulosics to synthesis gas has been demonstrated using sawdust. Agricultural wastes should constitute a potential raw material source.

1965-1021
TOTH, S. J.
Agricultural Value of Dried Poultry Manure and Bedding
Compost Sci. 5: Aut-Winter p. 29-30
Abst: C & S 65-0235

A six-inch layer of litter based on sugar cane bagasse was dried and applied in various amounts and with various additives to corn and beans. Chemical composition before and after drying and crop yields are tabulated.

1965-1022
WITZEL, S. A.; McCOY, Elizabeth; and LEHNER, Richard
Chemical and Biological Reactions from Lagoons Used for Cattle
ASAE Trans. 8: 449-451 [Paper No. 64-417]
Abst: McQ & B B-014; W71-05742

Studies were made of the conversion of the waste from six bulls in a five-ft deep lagoon in Wisconsin. Data are given for BOD, solids, organic nitrogen (NH_3 Nitrogen), pH, temperature, sludge build-up, odor, and bacterial types and quantities. "One can conclude that this lagoon is operating satisfactorily and is in good balance."

1965-1023
WOLF, Dean C.
Developments in Hog-Manure Disposal
ASAE Trans. 8: 107-109 [Paper 63-917]
Abst: McQ & B B-006, G-001

The big trend is to liquid manure handling. Lagoons, while valuable, are not unmixed blessings. Odor, especially in spring, and potential ground water pollution may result from their underdesign. Lagoons in series with periodic cleaning and field disposal are recommended.

The generation of electricity by utilizing the fuel value of gases from manure decomposition "with a setup patterned after some in Asia and Africa" is described. Few flies, little odor, and little ultimate disposal are among the advantages.

Distribution of liquid manure on crops by sprinkler irrigation deserves more consideration. It is proving effective in England.

1966-1001
AGNEW, R. W. and LOEHR, R. C.
Cattle-Manure Treatment Techniques
Proc. Symp. Mgmt. of Farm Animal Wastes p. 81-84
Abst: C & S 66-0193; McQ & B C-055; W71-02016

For manure handling from beef feedlots the combination of an anaerobic lagoon for the destruction and stabilization of organic matter followed by an aerobic lagoon for treatment of the effluent for ultimate disposal has several advantages. The cost may be moderate since the operator often possesses the excavating machinery required. Solids handling is simplified since the anaerobic lagoon may be located near the feedlot. Solids disposal is facilitated since the digested solids may be handled by pumping. Equipment for spreading or spraying is standard in the agricultural community. The size of lagoon may be moderate; volume, rather than area, being a design criterion deep lagoons are preferable. The effluent from the aerobic lagoon may find application for non-potable uses. The two-lagoon system facilitates runoff control.

1966-1002
ALLRED, E. R.
Farm-Waste Management Trends in Northern Europe
Proc. Symp. Mgmt. of Farm Animal Wastes p. 133-136
Abst: C & S 66-0194; McQ & B C-070; W71-02031

The most common method of manure handling in Northern Europe is land spreading, usually by honey wagon, but occasionally by irrigation pipe or ditch. Soil conditioning value of manure is highly regarded. Research emphasis is on reducing costs of handling and hauling manure rather than on major treatment facilities. Dehydration and use of oxidation ditches are receiving some attention. Methane production has dropped out of use.

1966-1003
AMMERMAN, C. B.; WALDROUP, P. W.; ARRINGTON, L. R.; SHIRLEY, R. L.; and HARMS, R. H.
Nutrient Digestibility by Ruminants of Poultry Litter Containing Dried Citrus Pulp
Jnl. Agr. Food Chem. 14: 279-281
Abst: McQ & B B-099

When dried citrus pulp was used as litter with broiler chicks then fed to lambs, the nitrogen and ash were greater in the combined droppings and citrus pulp than in the original pulp (percentage basis). The poultry litter diet had a higher apparent digestion coefficient for crude protein. "The results suggest that dried citrus pulp and perhaps certain other feeds can be used as poultry litter and subsequently fed to ruminants."

1966-1004
ANDERSON, John R.
Biological Interrelationships Between Feces and Flies
Proc. Symp. Mgmt. of Farm Animal Wastes p. 20-23
Abst: C & S 66-0589; McQ & B C-035; W71-01996

Animal concentrations led to intensification of the production of "filth flies" as contrasted with the beneficial "pasture flies" which remove much of the energy and organic load from droppings. Studies have shown that flies will be attracted from a wide area to lay eggs in manure concentrations. "Under proper manure removal and management programs, therefore, such enterprises can function as death traps for infinite numbers of potential flies in a community." Removal at five- to seven-day intervals followed by rapid drying is effective. Fly larvae can degrade manure and provide protein for chickens, animals, or even humans. African dung beetles have phenomenal performance records in disposing of elephant and other manure.

1966-1005
ANTHONY, W. Brady
Utilization of Animal Waste as a Feed for Ruminants
Proc. Symp. Mgmt. of Farm Animal Wastes p. 109-112
Abst: C & S 66-0493; McQ & B C-060; W71-02023

The exploratory development of formulae for treating cattle wastes and blending them with feed components is related. Accompanied by 13 tabulations of pertinent data, ANTHONY describes successful preliminary tests feeding 40 parts of washed fecal residue blended with 60 parts of basal feed. Later, residues retained on screens were mixed with basal feed for experiments with a few head of cattle. "The preliminary tests revealed that the excreta of feedlot cattle contains valuable nutrients in reasonably large amounts and that cattle will consume this product when it is combined with other feed ingredients." Commercially available screens having been found to be inadequate for a larger-scale test, a mixture of 40 parts fresh manure combined with 60 parts concentrate was prepared daily, held in cans overnight, and fed the next day. "Results of this test revealed that combining fresh, unwashed manure with concentrate feed was not a satisfactory practice in terms of animal gain and carcass grade." Either washing or heat treatment was found to be effective in improving the feed. Still later tests with an ensiled mixture of 57 parts manure and 43 parts coastal bermudagrass hay (89 lb) blended with 52 lb ground shelled corn and 1 lb of Auburn - 65 (urea - CSM mixture) led to excellent results. "The coastal-manure haylage had a pleasing, silage odor. Animals readily consumed it. Based on the results of this study, combining offers the cattle feeder a challenging opportunity to improve feed efficiency and at the same time reduces the cost of removing manure from feeding pens." A list of 23 references is included.

1966-1006
BELL, D. D.; CURLEY, R. G.; and LOOMIS, E. C.
Poultry Manure Removal Systems Used on California Poultry Ranches (Abst)
Poultry Sci. 45: 1069
Abst: McQ & B B-264

Wet and dry systems with frequent or infrequent handling have been effective for various sets of local circumstances. A strong educational effort is under way to improve manure management.

1966-1007
BENTLEY, Orville G.
Animal Waste Management at the Regional Level
Proc. Symp. Mgmt. of Farm Animal Wastes p. 148-150

The role of state experiment stations and of regional groups of experiment stations in providing interdisciplinary research on manure management problems is discussed.

1966-1008
BERRY, Edward C.
Requirements for Microbial Reduction of Farm Animal Wastes
Proc. Symp. Mgmt. of Farm Animal Wastes p. 56-58
Abst: C & S 66-0195; McQ & B C-048; W71-02009

A general introduction to microbiological action on organic wastes provides the bases for understanding the difficulties encountered with lagoons in cold climates. "If these manure lagoons are going to be more than storage pits, it will be necessary to equip them for agitating the material, supplying oxygen, providing sufficient water for dilution to an acceptable level, and increasing the temperature to a degree sufficient for microbial action."

1966-1009
BHATTACHARYA, Asok N. and FONTENOT, J. P.
Protein and Energy Value of Peanut Hull and Wood Shaving Poultry
    Litters
Jnl. Animal Sci. 25: 367-371
Abst: McQ & B B-203

Experiments, of which the procedures are described and chemical data are tabulated, were conducted on the effects of substituting 25 and 50 percent peanut hull litter and wood shaving litter in a corn-hay basal ration fed to sheep. "Digestibility of energy (76.4 percent) for the basal ration was greater than for the rations containing 25 or 50 percent litter. Kind of litter had no significant effect on digestibility of ration energy. . . The potential value of poultry litter in ruminant rations appears quite promising. The values of 22.7 percent digestible protein and 2440 kcal. of digestible energy per kg. compare favorably with corresponding values (all analyses) of 12 percent and 2479 kcal. per kg. for alfalfa hay."

1966-1010
BRIDGHAM, D. O. and CLAYTON, J. T.
Trickling Filters as a Dairy-Manure Stabilization Component
Proc. Symp. Mgmt. of Farm Animal Wastes p. 66-68
Abst: C & S 66-0196; McQ & B C-051; W69-01156

As a means of producing an effluent of good enough quality for release to streams or for recirculation as flushing water in a milking parlor the authors investigated treatment of diluted dairy manure by trickling filters. The results of their research indicated that almost any desired quality of effluent could be secured by appropriate selection of the loading rate. To produce an effluent BOD of 200 ppm from 346 to 391 cu ft of tanks per cow would be required. No cost data are included.

1966-1011
BROWN, L.; JAEGER, G.; STEVENS, F.; WHELDEN, H. C., Jr.; and
KITTRIDGE, C.
Deep Pit Cage Houses in Maine (Abst)
Poultry Sci. 45: 1073
Abst: McQ & B B-265

"There appears to be no one manure handling system that is optimum for all situations primarily because of the variation in 'value' of poultry manure in a given area. The 'market demand' if any, is an important influence. However, in most cases storage of manure, for varied lengths of time, enhances handling and disposal by providing flexibility." Deep pits provide an effective means of storage.

1966-1012
BROWN, Robert H.
Poultry Litter as Cattle Feed Discussed at Florida Event
Feedstuffs 38: 12 Nov. p. 6, 90

"The big question was not whether litter would make a potential feed but whether the country is ready for it." A litter based on beet or citrus pulp would cost more than the traditional sawdust, shavings, bagasse, etc., but would provide a better feed ingredient.

1966-1013
CASSELL, E. A.; WARNER, A. F.; and JACOBS, G. B.
Dewatering Chicken Manures by Vacuum Filtration
Proc. Symp. Mgmt. of Farm Animal Wastes p. 85-91
Abst: C & S 66-0197; McQ & B C-056; W71-02017

Large poultry facilities in an urban setting cannot employ land spreading as a method of manure disposal. The ultimate disposal techniques apparently available include burial, incineration, wet oxidation, fluidized bed oxidation, conversion to soil conditioner or animal feed supplement, and barging to sea. For all these procedures it is advantageous to have drier manure with its smaller volume and reduced weight. Vacuum filtration has been employed in the treatment of sewage sludges. With appropriate substitution of chemicals, it is also effective for dewatering poultry manure. Extensive laboratory testing is reported. An economic analysis has not been completed.

1966-1014
CASTLE, M. E. and DRYSDALE, A. D.
Liquid Manure as a Grassland Fertilizer. V. The Response to Mixtures of Liquid Manure (Urine) and Dung
Jnl. Agric. Soc. Cambr. 67: 397-404
Abst: McQ & B B-449

Slurry irrigation has been practiced in Switzerland, Austria, and Germany for years (Gülle System). In a three-year test in the UK marked reductions of yield occurred in the second and third years as the percentage of clover present decreased. The nitrogen efficiency as a fertilizer was directly related to the proportion of NH_3-N in the total nitrogen. Because of this, 100 percent urine was several times as effective in the production of dry matter as 100 percent dung.

1966-1015
CHENEY, Lloyd T.
Farm Animal Waste Problem as Viewed by Civil Engineers
Proc. Symp. Mgmt. of Farm Animal Wastes p. 9
Abst: C & S 66-0198; McQ & B C-029

Industrial-type concentrations lead to potential water pollution -- often with slug flows during and after precipitation. Municipal treatment practices are not generally applicable to animal waste problems.

1966-1016
COTTIER, G. J. and ROUSE, R. D.
Composition of Broiler House Litter as Affected by Number of Broods Raised (Abst)
Poultry Sci. 45: 1078

Studies at Auburn University on nutrients present in pine-shavings litter after one to six broods had been raised on it indicated that the greatest gain in N, P, and K occurred with the second brood. Maximum concentration occurred after four broods.

1966-1017
CROSS, Otis E.
Removal of Moisture from Poultry Waste by Electro-Osmosis (Part 1)
Proc. Symp. Mgmt. of Farm Animal Wastes p. 91-93
Abst: C & S 66-0199; McQ & B C-062; W71-02018

Laboratory experimentation in the removal of moisture from poultry manure by electro-osmosis is reported. A 57 percent decrease in moisture content occurred in the most successful test. For part 2 see [1966-1056].

1966-1018
CURTIS, David R.
Design Criteria for Anaerobic Lagoons for Swine Manure Disposal
Proc. Symp. Mgmt. of Farm Animal Wastes p. 75-80
Abst: C & S 66-0200; McQ & B C-054; W71-02015

Data are presented and discussed for eleven hog waste lagoons in South Dakota. Tentative design criteria proposed on the basis of this analysis are: a) provide a liquid volume of 75 to 100 cu ft per hog, b) provide a lagoon depth of at least five ft, c) provide adequate slope in the collection system and discharge conduit to assure trouble-free manure carriage, d) locate the discharge conduit above the center of the liquid surface, e) use a V-trough for manure carriage, and f) fence the lagoon adequately to assure safety.

1966-1019
DAVIS, E. H.
Cattle-Manure Handling and Disposal Systems on the West Coast
Proc. Symp. Mgmt. of Farm Animal Wastes p. 45-47
Abst: C & S 66-0201; McQ & B C-043; W71-02004

In stall housing of dairy cattle, very little bedding is mixed with the manure but the sloppy material is difficult to handle and to keep free of fly breeding. If liquid manure is disposed of by sprinkler irrigation, a follow-up application of water is important to a) make the pastures more palatable to the animals, b) get the fertilizer into the root zone promptly, and c) flush the irrigation pipe. "Lagoons appear to be satisfactory provided odors are not obnoxious to the community, no seepage occurs to contaminate water supplies, and the fertilizer value can be sacrificed."

1966-1020
DAVIS, R. V.; COOLEY, C. E.; and HADDER, A. W.

Treatment of Duck Wastes and Their Effects on Water Quality
Proc. Symp. Mgmt. of Farm Animal Wastes p. 98-105
Abst: C & S 66-0202; McQ & B C-058; W71-02021

Studies leading to the abatement of pollution from two duck farms in Virginia are discussed. The solution adopted consisted of providing alternatively-used earthen settling basins for removing solids followed by retention basins with a four-day holding period. Coliform organisms were reduced by 90 to 95 percent, and oyster harvesting downstream was resumed.

1966-1021
DECKER, W. M. and STEELE, J. H.
Health Aspects and Vector Control Associated with Animal Wastes
Proc. Symp. Mgmt. of Farm Animal Wastes p. 18-20
Abst: McQ & B C-034; W71-01995

"Over 100 diseases of animals may be transmitted to man. . . Some of the most significant bacterial zoonoses are salmonellosis, staphylococcal and streptococcal infections, tetanus, tuberculosis, brucellosis, leptospirosis, and colibacillosis." Routes of transmission and means of combatting several of these diseases are discussed. Feeding of animal feces to other animals presents significant hazards of spreading disease.

1966-1022
DEIBEL, R. H.
Biological Aspects of the Animal Waste Disposal Problem
AAAS Publn. 85, p. 395-399
Abst: McQ & B D-004

Various efforts (some unsuccessful, others nonfeasible for practical operations) to counteract the odor associated with poultry manure are reported. "Although no practical solution can be advanced, it would appear that chemical treatment for odor abatement is feasible."

1966-1023
DONEEN, L. D. (Editor)
Agricultural Waste Waters [Symposium]
Univ. of Cal., WRC Rpt. No. 10 368 p.

The interest of this symposium focused on irrigation return flows with minimal discussion of animal wastes. Two pertinent papers are abstracted separately: GOLUEKE and OSWALD [1966-1031] and HART [1966-1032].

1966-1024
DRYSDALE, A. D. and STRACHAN, N. H.
Liquid Manure as a Grassland Fertilizer. IV. The Effect of Liquid Manure on the Mineral Content of Grass and Clover
Jnl. Agric. Sci. 67: 337-343
Abst: McQ & B B-448

In fertilizer tests on grassland, applications of a) diluted cattle urine containing 0.26 percent N and 0.44 percent K supplying 0, 100, and 400 lb N and 0, 174, and 697 lb K/acre, b) fertilizer nitrogen supplying 0 and 200 lb N/acre, and c) potash fertilizer supplying 0 and 166 lb K/acre, were evaluated.

Liquid manure and/or potash fertilizer increased the potassium and decreased the sodium, calcium, magnesium, and phosphorus contents of both grass and clover. Nitrogen fertilizer has a slight effect in the opposite direction.

Liquid manure increases the ratio K/(Ca + Mg), thus tending to cause hypomagnesaemic tetany in grazing cattle.

1966-1025
DURHAM, R. M.; THOMAS, G. W.; ALBIN, R. C.; HOWE, L. G.; CURL, S. E.; and BOX, T. W.
Coprophagy and Use of Animal Waste in Livestock Feeds
Proc. Symp. Mgmt. of Farm Animal Wastes p. 112-114
Abst: C & S 66-0203; McQ & B C-061; W71-02024

Coprophagy has been observed in cattle fed limited quantities of an all-concentrate ration. In a testing program in which pullets and laying hens were fed a ration of which 10, 25, or 40 percent was manure from cattle fed on the all-concentrate ration slightly fewer eggs resulted at 25 and 40 percent, and more at 10 percent than in the control ration with no manure. Digestibility of dry matter decreased as the percentage of manure increased. No differences in fertility among incubated eggs were observed at the four rations.

Catfish responded well to all-concentrate cattle manure as long as care was taken to prevent oxygen depletion in the ponds.

1966-1026
EBY, Harry J.
Two Billion Tons of -- What!
Compost Sci. 7: Autumn p. 7-10
Abst: W71-05745

"Eby's Law says that if you want to get a disagreeable job done, make it profitable." He proposed grass belts on contours, with the grass growing in rich deposits of composted animal and municipal wastes, to act as silt and debris traps and sources of hay. The proposal is based on the considerations that 1) soil with a high organic content holds more water, 2) incorporation of organic matter in clay improves its percolation rate, and 3) soil is a good bacterial filter.

1966-1027
EBY, Harry J.
Evaluating Adaptability of Pasture Grasses to Hydroponic Culture and
Their Ability to Act as Chemical Filters
Proc. Symp. Mgmt. of Farm Animal Wastes p. 117-120
Abst: C & S 66-0204; McQ & B C-065

Experiments with the hydroponic growing of various grasses in the greenhouse and in test plots are described. To be useful such plants should deplete N, P. or K in the effluent in which they are grown. They should be nutritious to livestock, and they should be easily harvested. Advantages of hydroponic agriculture include a) the ability to utilize manure with a minimum of handling, b) a potentially higher yield per acre for some crops than can be obtained by conventional agriculture, and c) an improvement in sanitation of both the farmer and his livestock. Sewage plant effluent should be an excellent hydroponic medium.

1966-1028
FOERSTER, E. L., Sr.
Role of the Renderer in the Use and Disposal of Animal Wastes
Proc. Symp. Mgmt. of Farm Animal Wastes p. 114-117
Abst: McQ & B C-064; W71-02025

The renderer has equipment for converting manure, or some of its components, sufficiently to "circumvent the stigmas, reservations, and variability inherent in a direct manure product."

1966-1029
FONTENOT, J. P.; BHATTACHARYA, A. N.; DRAKE, C. L.; and McCLURE, W. H.
Value of Broiler Litter as Feed for Ruminants
Proc. Symp. Mgmt. of Farm Animal Wastes p. 105-108
Abst: C & S 66-0515; McQ & B C-059; W71-02022

The litter samples analysed contained an average of 32 percent crude protein, dry basis. The average digestion coefficient of the crude protein was 72.5 percent. Chemical analyses of litters are tabulated. When the litter was autoclaved at 116°C under a pressure of 1.06 kg/sq cm for forty minutes, air dried, and finely ground, it supplied substantial protein and energy value for ruminants in feeding tests. Performance data are tabulated. No unpleasant flavor was imparted to the meat.

Litters to be used for feeding should be checked for objectionable drug and pesticide residues. Other harmful organisms might also be present in some circumstances.

1966-1030
GILBERTSON, Wesley E.
Animal Wastes: Disposal or Management
Proc. Symp. Mgmt. of Farm Animal Wastes p. 144-145
Abst: McQ & B C-073

Animal waste disposal is a subfield of the much larger problem of environmental contamination. Utilization, not mere disposal, will be required in an ultimate solution. Composting for reclamation of marginal lands and combustion on fluidized beds for production of heat are among the more promising processes.

1966-1031
GOLUEKE, Clarence G. and OSWALD, W. J.
Treatment and Reclamation of Agricultural Waste Waters
Proc. Symp. on Agricultural Waste Waters. Davis, Cal. p. 286-292

For animal wastes, treatment by lagooning and facultative ponds is described. Reclamation of both water and nutrients (in the form of algae) is advocated. Some cost data are included, as are 19 references.

1966-1032
HART, Samuel A.
Agricultural Wastes and the Waste Water Problem
Proc. Symp. on Agricultural Waste Waters. Davis, Cal. p. 14-16

Manures should preferably be returned to the soil following the pattern of Nature's recycling. Lagoons on porous soil may pollute groundwater.

1966-1033
HART, Samuel A.
Future Research in Animal Wastes
Proc. Symp. Mgmt. of Farm Animal Wastes p. 150-151

For immediate application, research on odor control and optimum manure disposal practices on croplands is required. For the long-range, the extraction of lignins and celluloses for building materials, the uses as fuel, and the extraction of vitamins and other chemicals deserve attention. Combining and composting agricultural and municipal wastes may simplify the problems of both town and country.

1966-1034
HART, S. A.; MOORE, J. A.; and HALE, W. F.
Pumping Manure Slurries
Proc. Symp. Mgmt. of Farm Animal Wastes p. 34-38
Abst: C & S 66-0205; McQ & B C-039; W71-02000

Results of testing three centrifugal, a positive displacement, and a diaphragm pump on manure slurries of various solids content are reported. At low solids content, pipe friction losses were less than for water, but when the slurry became thick, frictional losses were much greater than for water. Pumps should be selected on the basis of actual tests with the material to be pumped rather than by extrapolating tests with water. Since manure pumps are designed to be non-clogging, efficiencies are low. The authors recommend a slurry with solids content between 1 and 3 (or perhaps 4) percent for all manures. This may simplify manure moving at the expense of manure disposal.

1966-1035
HINTZ, H. F.; HEITMAN, H., Jr.; WEIR, W. C.; TORELL, D. T.; and
MEYER, J. H.
Nutritive Value of Algae Grown on Sewage
Jnl. Animal Sci. 25: 675-681
Abst: McQ & B B-204

Marine algae have been used for iodine, fertilizer, and feed for livestock. The nutritive values of unicellular algae grown on sewage have been studied previously for rats and chicks. This paper reports feeding tests for pigs, cattle, and sheep. Algae have a high crude protein value, about equal to that of soybean or cottonseed meal, but with considerable ash. The digestibility of the cell walls is low. Algae must be pelleted with tasty components or animals will avoid them. Algae appear, however, to have potential as a livestock feed, particularly for ruminants, "because of the high content of protein, plus significant amounts of carotene, phosphorus, calcium and trace minerals."

1966-1036
HOBBS, Charles S.
Farm Animal Waste Problem
Proc. Symp. Mgmt. of Farm Animal Wastes p. 9, 14
Abst: McQ & B C-030

"The concentration of animals in large feedlots and the terrific population explosion is creating major problems of odors, public agitation, public health, etc." Agriculture, becoming more and more a minority group, must guard its public relations.

1966-1037
HOWES, J. R.
On-Site Composting of Poultry Manure
Proc. Symp. Mgmt. of Farm Animal Wastes p. 68-69
Abst: McQ & B C-052; W71-02013

By means of an inoculum, "Litterlife," containing 46 strains of aerobic bacteria and fungi together with other ingredients, used poultry litter may be composted in place with the resulting composted litter being dry, odorfree, and unattractive to flies. The process may be repeated several times by adding more inoculum and water and then remixing mechanically. Such treatment of litter permits the maintenance of optimum humidity for poultry health without employing damp litter with its potential for producing ammonia in quantities toxic to poultry. The process can restore litter which has been flooded or on which diseased poultry have been confined.

1966-1038
IRGENS, R. L. and DAY, D. L.
Laboratory Studies of Aerobic Stabilization of Swine Waste
Jnl. Agric. Engr. Rsch. 11: 1-10
Abst: McQ & B B-106

"Disposal of swine wastes is a problem involving economics, sanitation and aesthetics." A laboratory investigation of the merits of aerobic stabilization is reported. Continuous operation proved to be preferable. The treatment made the swine waste virtually odorless and stable. An estimated 36 kwh per pig per year should power an effective aerator rotor in an oxidation ditch. Chlorination of the diluted (6 cu ft from a 150-lb pig) waste improved odor and reduced COD.

1966-1039
IRGENS, R. L. and DAY, D. L.
Aerobic Treatment of Swine Waste
Proc. Symp. Mgmt. of Farm Animal Wastes p. 58-60
Abst: C & S 66-0207; McQ & B C-049; W71-02010

Aerobic treatment of swine wastes would have the advantages of being odor-free and producing a high degree of stabilization. The laboratory tests reported were not unqualified successes. A field laboratory employing an oxidation ditch was completed in the spring of 1966. Results were not available at the time of preparation of this paper.

1966-1040
JORDAN, Herbert C.

Poultry Manure Marketing
Proc. Symp. Mgmt. of Farm Animal Wastes p. 132-133
Abst: C & S 66-0209; McQ & B C-069; W71-02030

Replies to a 31-question survey on the marketing of poultry manure are tabulated and discussed. Value as a soil conditioner should be emphasized in advertising.

1966-1041
KESLER, Richard P.
Economic Evaluation of Liquid-Manure Disposal from Confinement Finishing of Hogs
Proc. Symp. Mgmt. of Farm Animal Wastes p. 122-125
Abst: C & S 66-0210; McQ & B C-067; W71-02028

An economic analysis of the choice of manure disposal system should consider a) the amount of manure that is produced, b) the fertility content of the manure and its value as a replacement for commercial fertilizer, c) the disposal costs of each system, and d) the availability of cropland on which to spread the manure. Case studies are presented.

1966-1042
LINN, Alan
Whipping the Manure Problem
Farm Qtrly. 21: Winter p. 56-59, 115-116
Abst: McQ & B F-023; W71-05422

The oxidation ditch is illustrated, explained, and extolled. It goes hand-in-hand with a slatted livestock building. Proposed dimensions and estimated costs are given based on research at Purdue University. Three hundred successful installations for municipal sewage in Europe are cited as proof of effectiveness.

1966-1043
LITTLE, F. J.
Agriculture and the Prevention of River Pollution, as Experienced in the West of Scotland
Inst. Sew. Purif., Jnl. and Proc. 65: 452-454
Abst: W71-05421

With relatively small installations (average dairy herd of 40 cows) and availability of land, manure is prized for its fertilizer value. "In 1957 the volume of urine discharged in Scotland was 219 mil gal. . . the value of this urine has been estimated at £ 1.267 million." Precautions to prevent runoff to surface streams are becoming increasingly necessary.

1966-1044
LUDINGTON, David C.
Properties of Chicken Manures Affecting Their Disposal
AAAS Publn. 85, p. 401-413
Abst: McQ & B D-005

Land disposal is regarded as being the only acceptable destiny of chicken manure. Desirata in processing are 1) elimination of odor nuisance, 2) reduction in mass to be hauled or pumped, and 3) reduction of BOD to reduce possibility of odor developing after spreading. Neither aerobic nor anaerobic biological treatments are ideal. Large quantities of polluted water in the first, and odors, malfunctions, and costs in the second are discouraging. Rapid drying is mentioned, but not advocated.

1966-1045
MacDONALD, F. W. and DAVIS, H. R.
BOD of Captive Wild Animal Wastes
Wtr. and Sew. Wks. 113: 64-67

Road zoos and serpentariums tend to handle solid waste by composting in piles or pits. Odors are reduced by adding lime. Fixed zoos tend to rely on municipal treatment plants. With zoos increasing in number and size, an interest in waste analysis arises. This is even more important in regard to the wastes from primates and other animals which have been used for research on human disease. The authors tabulate BOD measurements from the fecal matter of animals in a New Orleans zoo.

1966-1046
MAW, A. J. G.
Poultry Science Viewpoint of Farm Animal Waste Problem
Proc. Symp. Mgmt. of Farm Animal Wastes p. 10
Abst: McQ & B C-031

Few poultrymen have convenient land, adequate in area, on which to employ poultry manure as fertilizer. Hopefully, some means can be found to convert the material to something useful.

1966-1047
MAY, D. M. and MARTIN, W. E.
Manures are Good Sources of Phosphorus
Calif. Agr. 20: July p. 11-12
Abst: McQ & B E-108

Alfalfa in Antelope Valley, Los Angeles County, did as well or better on manure as on commercial superphosphate fertilizer. Cost analyses were not made. A grass-alfalfa sequence is recommended since grass tends to take up excess nitrates leaving the phosphorus for the alfalfa.

1966-1048
McANDREWS, C. J. and KERR, H. A.
The Impact of Water Pollution on Agriculture
Background Paper A4-1-7, Natl. Conf. Pollution and Our Environment,
Montreal 9 p.

"Manure disposal lagoons are an answer to a great quantity of livestock and poultry manure." They must, however, be employed with caution.

Poultry litter used as cattle feed supplies protein from the undigested poultry feed and from bacteria which develop in the litter.

Composted poultry manure has a market.

1966-1049
MEHREN, George L.
Aesthetics, Economics -- Animal Waste
Proc. Symp. Mgmt. of Farm Animal Wastes p. 4-7
Abst: C & S 66-0212; McQ & B C-026

The present and projected future roles of the USDA in pollution control (not absolute elimination) are discussed. Animal waste "does not appear generally to be among the most hazardous of the pollutants that are generated as virtually inevitable concomitants of fruitful and desirable agricultural activity." Affirmative lines are being explored in the expectation that manure may become an economic asset with minimal aesthetic offenses or hazards.

1966-1050
MINER, J. R.; FINA, L. R.; FUNK, J. W.; LIPPER, R. I.; and LARSON, G. H.
Stormwater Runoff from Cattle Feedlots
Proc. Symp. Mgmt. of Farm Animal Wastes p. 23-27
Abst: C & S 66-0215; McQ & B C-036; W71-01997

Field tests with simulated rainfall are described and the results are analyzed. Slug flows resulting from storms carry high concentrations of nitrogen, solids, and bacteria. Such flows should be modified by dilution in a detention pond to reduce potential fish kills and other detrimental downstream effects. Good housekeeping in feedlots can reduce the pollution potential substantially.

1966-1051
MINER, J. R.; LIPPER, R. I.; FINA, L. R.; and FUNK, J. W.
Cattle Feedlot Runoff -- Its Nature and Variation
WPCF Jnl. 38: 1582-1591
Abst: McQ & B B-069; W71-08206

Runoff from cattle feedlots, produced during and immediately after rainfall, is particularly objectionable in warm weather, in storms of low rainfall intensity, and when the manure has been rendered soluble by presoaking. The runoff has high BOD and carries high concentrations of bacteria normally considered as indices of sanitary quality. Concrete-surfaced lots produce more pollution than unsurfaced lots under similar conditions.

1966-1052
MORRIS, W. H. M.
Economics of Liquid-Manure Disposal from Confined Livestock
Proc. Symp. Mgmt. of Farm Animal Wastes p. 126-131
Abst: C & S 66-0219; McQ & B C-068; W71-02029

Fertilizer economics are based primarily on N, P, and K values. These may decrease severely with storage or with spreading at an unfavorable time of year. It is seldom that fertilizer value will equal handling costs. While manure has use as a feed, a source of combustible gases, a nutrient for algae, a source of fibers which might be useful in paper manufacture, fuel or a component of adobe building, none of these uses would appear to hold much promise for making manure economically attractive.

1966-1053
MORRISON, C. S.
Farm Animal Waste Problem
Proc. Symp. Mgmt. of Farm Animal Wastes p. 8
Abst: C & S 66-0220; McQ & B C-028

The ASAE organized its Rural Waste Disposal Committee X-12 shortly after the 1958 annual meeting and has participated in several symposia since.

1966-1054
MORRISON, S. R.; MENDEL, V. E.; and BOND, T. E.
Sloping Floors for Beef-Cattle Feedlots
Proc. Symp. Mgmt. of Farm Animal Wastes p. 41-43
Abst: C & S 66-0221; McQ & B C-041; W71-02002

Slopes of up to 7° have no effect on weight gain or efficiency of cattle, while a nearly flat floor, with its accumulation of manure, may depress gains. Slopes above 5° are nearly self-cleaning, particularly if slots are provided at the lower end and some flushing is employed.

1966-1055
MYERS, Earl A.
Engineering Problems in Year-Round Distribution of Waste Water
Proc. Symp. Mgmt. of Farm Animal Wastes p. 38-41
Abst: McQ & B C-040; W71-02001

Some of the problems encountered by Penn State University in spreading municipal sewage treatment plant effluent by sprinkler irrigation on a year-round basis are described. Similar problems could be anticipated in a similar disposal system for animal wastes. Clogging, freezing and pressure variations are the major sources of trouble.

1966-1056
NURNBERGER, F. V.; MACKSON, C. J.; and DAVIDSON, J.
Removal of Moisture from Poultry Waste by Electro-Osmosis (Part 2)
Proc. Symp. Mgmt. of Farm Animal Wastes p. 93-95
Abst: C & S 66-0223; McQ & B C-063; W71-02018

Further testing of electro-osmotic drying, varying some parameters which CROSS [1966-1017] held constant, is reported. "The maximum moisture-content reduction was 4.8 percent wb [wet basis] based on 22 hr of operation at 20 v. This was not sufficient to reach a pelletable level from the initial value of 80 percent wb. The cost of the electric energy used was 12.7 ¢ per gal of liquid removed based on the rate of 2 ¢ per kw-hr."

1966-1057
OMOHUNDRO, R. E.
USDA Advises Against Using Litter as Livestock Feed
Poultry Digest 25: 156

In an item credited as a USDA Release, the "USDA strongly recommends that poultry litter not be used as livestock feed." Variability of nutritive value, effect of drugs, and possibility of disease transmission are stressed. Much research is needed.

1966-1058
OSTRANDER, Charles E.
Methods of Handling Poultry-Waste Materials
Proc. Symp. Mgmt. of Farm Animal Wastes p. 32-33
Abst: C & S 66-0225; McQ & B C-038; W71-01999

Problems of poultry waste handling are discussed under the headings removal, storing, loading, spreading, and processing and disposal. "Dehydration shows a great deal of promise for processing non-liquid manures. . . Incineration may be practical in some situations." Composting and lagooning are poorly adapted to northern climates.

1966-1059
PALMER, Lane and WILMORE, Rex
New Threat to Farmers
Farm Journal 90: Nov. p. 36, 95-96

Pollution charges are being raised over alleged runoffs leading to fishkills and nitrate penetration to groundwater. Feedlots should be built well away from streams. Lagoons should be provided. Manure should not be spread on frozen ground.

1966-1060
PARKER, M. B.
Chicken Manure on Orchard Grass -- Ladino Clover
Georgia Ag. Ex. Sta. Bull. N. S. 159 15 p.

"Manure, even at the lowest rate applied, was more effective than the highest rate of fertilizer in forage production, apparently because of the extra N being supplied by manure. . . Fertilizer influenced yields only at the first harvest; whereas manure was effective throughout the growing season."

Either fertilizer or manure caused the clover to vanish within three years of application.

1966-1061
QUISENBERRY, J. H.; MALIK, D. D.; and IBARBIA, Ramon
Water Metabolism Studies May Assist with Waste Disposal
Proc. Symp. Mgmt. of Farm Animal Wastes p. 49-51
Abst: C & S 66-0227; McQ & B C-045; W71-02006

Wet poultry droppings produce more odors, promote greater fly production, and are more repulsive to handlers than are drier droppings. Under conditions at Bryan, Texas, baffle boards decreased moisture content of droppings nearly 50 percent and decreased fly hatch from 70.5 flies per 32 cu in of droppings to 2.5 flies. Feeding of bentonite or clay at 2.5 and 5 percent levels of the diet improved body weight of the hens and increased egg size while reducing moisture content about 2.5 and 5 percent. Genetic selection of breeds with drier feces appears to be a further possibility.

1966-1062
REED, Charles H.
Disposal of Poultry Manure by Plow-Furrow-Cover Method
Proc. Symp. Mgmt. of Farm Animal Wastes p. 52-53
Abst: C & S 66-0228; McQ & B C-046; W71-02004

The plow-furrow-cover method of disposal of poultry manure has operated successfully with a 1-to-2 inch slurry deposit in a 6-to-8 inch deep furrow with covering occurring in the same or a subsequent operation. A 2-inch layer is equivalent to 225 tons per acre. Mechanical improvements have been made, land utilization schedules developed, and an experimental program to test maximum land handling capacity established.

1966-1063
RILEY, C. T.
Poultry Manure Disposal -- Is There A Problem?
Agriculture 73: 110-112
Abst: C & S 66-0229; McQ & B E-007; W71-03579

"In truth, there is only one problem with muck, it is just not fashionable any more. It is far easier to say 'it's cheaper to use artificials' than to attack the problem. The fact is that among all concerned, whether on the farm or off, nobody is very interested." Such was the situation in the UK in 1966.

Troubles were largely related to the nearness of neighbors and their objection to odor. Trends were away from hydraulic handling to dry storage awaiting effective land distribution. Only a few producers were employing drying and little increase in the practice was anticipated.

1966-1064
RUSNAK, John J.; LONG, T. A.; and KING, T. B.
Hydrolyzed Poultry Waste as a Feed for Cattle (Abst)
Jnl. Animal Sci. 25: 909
Penn State Univ. Animal Sci. Mimeo 4-66
Abst: McQ & B B-205

One group of steers was fed a corn and cob diet with 10 percent soybean meal; another had 10 percent hydrolyzed poultry waste (HPW) substituted for the soybean meal. Daily gains were identical (0.98 kg). The HPW was processed by autoclaving fecal matter, feathers, and waste feed.

1966-1065
SCHELTINGA, H. M. J.

Aerobic Purification of Farm Waste
Inst. Sew. Purif., Jnl. and Proc. 65: 585-588
Abst: W71-04920

Under Dutch conditions lagooning is not practical since the land is too valuable and too porous. Mechanical or chemical treatment is too expensive. Laboratory and prototype investigations of an oxidation ditch of reinforced concrete followed by a final sedimentation tank are described and costs for the disposal of undiluted pig waste are given. "The surplus sludge can be withdrawn a few times a year and used as an organic fertilizer without causing smell nuisance."

1966-1066
SCHELTINGA, Henri M. J.
Biological Treatment of Animal Wastes
Proc. Symp. Mgmt. of Farm Animal Wastes p. 140-143
Abst: C & S 66-0230; McQ & B C-072; W71-02033

Swine wastes in Holland are most economically handled by means of oxidation ditches. Data for an experimental ditch are presented and discussed. Conventional systems of aerobic treatment are unsatisfactory and excessively expensive.

1966-1067
SOBEL, A. T.
Physical Properties of Animal Manures Associated with Handling
Proc. Symp. Mgmt. of Farm Animal Wastes p. 27-32
Abst: C & S 66-0233; McQ & B C-037; W71-01998

"This paper is concerned with various physical properties of chicken and dairy cow manure that have a relationship to handling." The properties in question are a) basic physical composition (moisture, total solids, volatile solids, and fixed solids), b) particle density and bulk density, c) production, d) particle size and distribution, e) dilution, f) settling rate, g) suspended and dissolved solids, h) flowability, and i) freezing point. Laboratory procedures for the determination of these properties are described and discussed. Variations due to different feeds, environments, and animal breeds make the obtaining of a typical sample difficult. Published values are scattered widely. The properties vary so widely that no single method of manure handling is universally best.

1966-1068
SOBEL, A. T. and LUDINGTON, D. C.
Destruction of Chicken Manure by Incineration
Proc. Symp. Mgmt. of Farm Animal Wastes p. 95-98
Abst: C & S 66-0232; McQ & B C-057; W71-02020

Calculations, based on average BTU values of chicken manure, of mass and energy balances for the destruction of the organic content of the manure are presented. It may well be that incineration will prove to be the most economical method of disposal inasmuch as it utilizes its own energy for destruction. No formal cost analysis is offered. "Future applications of incineration will depend on cost factors and possible air pollution hazards."

1966-1069
STUBBLEFIELD, Thomas M.
Problems of Cattle Feeding in Arizona as Related to Animal-Waste Management.
Proc. Symp. Mgmt. of Farm Animal Wastes p. 120-122
Abst: McQ & B C-066; W71-02027

Feedlots in the vicinities of Phoenix and Tempe have been subjected to legal harassment because of odor nuisance. Casa Grande has zoned 22 sections of land for feedlots. Manure, a valuable conditioner for Arizona soils, is produced in quantities much in excess of demand.

1966-1070
TAIGANIDES, E. Paul
The Animal Waste Disposal Problem
AAAS Publn. 85, p. 385-394
Abst: McQ & B D-003

Anaerobic lagoons, after design criteria have been perfected, may become the best solution to swine and poultry waste disposal. Odor, groundwater hazards, space requirements, and functional upsets caused by antibiotics in the influent are among their problems.

Ultimate disposal, to the land, will require better management to preserve water and air quality and avoid nuisance suits filed by neighboring suburbanites.

1966-1071
TAIGANIDES, E. Paul
Symposium Prologue
Proc. Symp. Mgmt. of Farm Animal Wastes p. 1-2

The three main objectives of the National Symposium on Animal Waste Management were 1) to delineate the problem of managing animal wastes; 2) to evaluate current technology in the handling, treatment, utilization, and disposal of farm wastes; and 3) to stimulate and give new direction to future research in solid wastes management.

1966-1072
TAIGANIDES, E. Paul and HAZEN, T. E.
Properties of Farm Animal Excreta
ASAE Trans. 9: 374-376 [Paper 64-315]
Abst: McQ & B B-016

Manure is not sewage and should not be measured by the same yardstick. Physical characteristics depend strongly upon the ration fed and the environment. Old data usually include bedding material and are oriented toward plant nutrient value. Chemical and biological characteristics of major interest are BOD, COD, and PE (population equivalent). This latter is defined in several contradictory manners and should be evaluated with great caution. Gas and odor information is almost completely lacking.

1966-1073
TIETJEN, Cord
Plant Response to Manure Nutrients and Processing of Organic Wastes
Proc. Symp. Mgmt. of Farm Animal Wastes p. 136-140
Abst: C & S 66-0234; McQ & B C-071; W71-02032

The effect of manure on soil conditioning and crop yield depends on a) the means of distribution of manure to the land, b) the ratio of carbon to nitrogen, and c) the available nitrogen portion of the total nitrogen. "Depending on different arrangements of these three factors, different effects on crop yield are to be observed, ranging from depressing to very high. According to this scale, only liquid manure has a high or very high yield effect." Experiments with gülle manure production and utilization are discussed.

1966-1074
WEBSTER, N. W. and CLAYTON, J. T.
Operating Characteristics of Two Aerobic-Anaerobic Dairy Manure Treatment Systems
Proc. Symp. Mgmt. of Farm Animal Wastes p. 61-65
Abst: C & S 66-0235; McQ & B C-050; W69-00413

Bench and pilot-scale models of two systems for application of the activated sludge process to dairy cattle wastes are described. No cost data are cited.

1966-1075
WILLRICH, Ted L.
Disposal of Animal Wastes
AAAS Publn. 85, p. 415-428
Abst: McQ & B D-006

Conversion of manure to marketable products by stockpiling with anaerobic fermentation, dehydration, or composting have all had local successes. The market, however, is small and the costs high. Incineration and landfill have not proven satisfactory.

Land disposal, with due regard for prevention of runoff and for overloading, provides fertilizer value and provides treatment for what runoff does occur.

1966-1076
WILLRICH, T. L.
Primary Treatment of Swine Wastes by Lagooning
Proc. Symp. Mgmt. of Farm Animal Wastes p. 70-74
Abst: C & S 66-0236; McQ & B C-053; W71-02014

Based on experimental hog lagoons at Iowa State University and a wide acquaintance with other swine waste lagoons throughout the Midwest, WILLRICH summarizes performance characteristics and gives the following two recommended design criteria. 1) "For anaerobic lagoons which will receive fairly uniform and frequent (once-a-week or less) loadings: allow a minimum of 1 cu ft of lagoon water volume per pound of total animal weight confined in a hog-finishing building, plus additional lagoon volume for sludge storage. 2) For lagoons which will receive non-uniform and intermittent loadings: allow a minimum of 2 cu ft of lagoon water volume per pound of total animal weight confined in a hog-finishing building, plus additional lagoon volume for sludge storage."

1966-1077
WITTWER, S. H.
Animal Waste Management
Proc. Symp. Mgmt. of Farm Animal Wastes p. 7-8
Abst: C & S 66-0237; McQ & B C-027

No one solution to animal waste management is universally optimum. Success will be obtained by creating "a valuable natural resource -- fertilizers and soil amendments that can both benefit American agriculture and effect permanent animal waste disposal."

1966-1078
WITZEL, S. A.; McCOY, E.; POLKOWSKI, L. B.; ATTOE, O. J.; and
    NICHOLS, M. S.
Physical, Chemical and Bacteriological Properties of Farm Wastes
    (Bovine Animals)
Proc. Symp. Mgmt. of Farm Animal Wastes p. 10-14
Abst: C & S 66-0238· McQ & B C-032; W71-01993

Animal wastes supply humus to the soil and optimize the utilization of fertilizer values by plants. Spreading on frozen land in winter can, however, lead to washing of pollutants into surface waters. Chemical analyses of cattle wastes are tabulated and laboratory procedures for their determination are discussed. Bacteriological studies on aerobic, facultative, and anaerobic bacteria indicate that lagoon flora are generally well balanced to carry out decomposition of a highly-nitrogenous waste. Land application of liquid manure is recommended.

1966-1079
ANON
Animal Waste Management Symposium
Agr. Engrg. 47: 338-340

Topics discussed at the National Symposium on Animal Waste Management, Michigan State University, 5-7 May 1966 are reviewed briefly.

Reuse as feed after heating or washing with monitoring for dangerous drug or pesticide residues appears to be successful. Some authorities ". . . report adequate results with up to 50 percent reprocessed waste mixtures, with no significant incidence of animal refusal. . . Catfish in stocked ponds thrive on it!"

Lagoon systems combining anaerobic and aerobic lagoons may solve groundwater contamination, odor, and sludge problems often found with simple lagoons.

Interest seems to be declining in the use of manure as a low-grade fuel.

1966-1080
ANON
Antelope Valley Feeders . . . A Double-Duty Feedlot
CALF News 4: July, p. 12-14

Forty miles north of Los Angeles a feedlot utilizes its manure by stockpiling it for a period of time to eliminate viable weed seeds, then runs it through a processing plant which grinds and screens it. It is then sold in bulk or bags to turfgrass contractors, nurseries, or other retail outlets.

1966-1081
ANON
Problems with Indoor Lagoons
Pacif. Poultryman June
Reprint: Poultry Digest 25: 468 (1966)

Problems listed are odors, stream pollution by the effluent, lack of actual decomposition of manure, damage to the eyes of the birds, off-flavor eggs, costly hauling of excess water for disposal, and production of flies.

1966-1082
ANON
Hog Waste Treatment Lagoons
Pub. Wks. 97: Oct. p. 80, 82
Abst: C & S 66-0206

"Attempts to lagoon [hog] wastes have resulted in odor production, polluted streams from overflows, and abandoned units resulting from excessive solids accumulation." Illinois recommends non-overflow lagoons with no more than 250 hogs per acre of water surface for 6-ft depth or 300 hogs per acre with 7-ft depth (1000 cu ft per hog).

1967-1001
ANTHONY, W. Brady
Manure-Containing Silage -- Production and Nutritive Value (Abst)
Jnl. Animal Sci. 26: 217
Abst: McQ & B B-207

A silage of feedlot manure and ground coastal bermuda grass proved palatable and nutritious as the sole diet for test ewes over a year. "The silage-fed animals consumed less hay [0.97 kg vs. 1.57 kg], but remained in better physical condition" than the control ewes fed hay with no manure. The ration was also tested on steers and beef heifers.

1967-1002
BLACK, S. A.
Farm Animal Waste Disposal
Ontario Water Resources Comm. Rsch. Publn. No. 28 36 p.
Abst: McQ & B A-298

This very readable state-of-the-art survey is oriented toward finding solutions pertinent to Ontario. A 44-entry bibliography is included.

The family farm is being replaced by agribusiness, with an industry's responsibility for the pollution problems which have resulted. Despite the difficulties involved when livestock and crop producers are distinct, with the crop producer able to use commercial fertilizers at less cost than "free" manure, ". . . the application of manure to soils is well justified and desired."

"Generally, the farm animal waste disposal problem is one of collecting and holding manure until it can be distributed on the land, this being generally in the spring and fall depending upon the crops being grown. The difficulties arising in such a waste disposal method involve the size of tank required to store the manure, the odours and gases released, and in some cases, the difficulty of mixing the contents before disposal on the land. . . Basically, treatment and disposal must ensure four things: that there is no hazard to the health of farm animals if disposal is to farmland; that treatment facilities are flexible in design and operation to allow for the various types and quantities of wastes, some being produced continually and others infrequently; that the performance of the treatment plant justifies its capital and operating costs; that ground and surface water pollution are minimal."

Advantages and disadvantages of composting, anaerobic digestion (too expensive and complicated for farm use), lagooning, and aerobic treatment are discussed. ". . . the methods of disposal available to the farmer may well control the location and magnitude of his enterprise in the future."

1967-1003
BRADY, Nyle C. [Editor]
Agriculture and the Quality of Our Environment
AAAS Publn. 85 XV + 460 p.
Review: LUTZ, J. F. Envir. Sci. and Tech. 2: 1046-1047 (1968)

In this symposium, held at the annual meeting of the AAAS in December, 1966, five papers were devoted, at least in part, to the problems of animal waste disposal. Four of these are abstracted separately:

DEIBEL, R. H.: Biological Aspects of the Animal Waste Disposal Problem. p. 395-399 [1966-1022],

LUDINGTON, David C.: Properties of Chicken Manures Affecting Their Disposal. p. 401-413 [1966-1044],

TAIGANIDES, E. Paul: The Animal Waste Disposal Problem. p. 385-394 [1966-1070], and

WILLRICH, Ted L.: Disposal of Animal Wastes. p. 415-428 [1966-1075].

Kenneth C. WALKER, in "Agricultural Practices Influencing Air Quality" (p. 105-111) mentioned manure odor as one of several types of air pollution.

No panaceas were proposed.

1967-1004
BRUGMAN, H. H.; DICKEY, H. C.; PLUMMER, B. E.; and POULTON, B. R.

Digestibility of Sterilized Poultry Litter (Abst)
Jnl. Animal Sci. 26: 915
Abst: McQ & B B-208

Poultry litter sterilized at 135°C for eleven hours had significantly lower digestibility than untreated litter when fed to sheep.

1967-1005
EASTWOOD, Roy E.; KADA, Jimmy M.; SCHOENBURG, Robert B.; and BRYDON, Harold W.
Investigations on Fly Control by Composting Poultry Manures
Jnl. Econ. Entom. 60: 88-96
Abst: McQ & B B-583; W71-07549

Windrow composting of poultry manure was investigated during several months of the year. It was unnecessary to grind the manure before composting or to add bulking or drying materials. A twice-weekly turning schedule eliminated the fly problem. Once composted, the material is of no further interest to flies.

1967-1006
HANKS, Thrift G.
Solid Wastes/Disease Relationships: A Literature Survey
USPHS Rpt. SW-1c. 179 p.

Diseases associated with animal fecal wastes are discussed on p. 77-86 with emphasis on those involving salmonellae. Recommendations are that intensified study be given the sanitary aspects of animal waste disposal. Effectiveness of operational, as contrasted to laboratory, composting should be determined. Education of children and farmers on the hazards involved is necessary.

1967-1007
HILEMAN, L. H.
The Fertilizer Value of Broiler Litter
Ark. Agr. Ex. Sta. Report 158. 12 p.
Abst: McQ & B E-119

Litter "is probably the most valuable by-product produced on the poultry farm." Its composition is discussed and its value is cited as about $12 per ton on the basis of cost of equivalent N, P, and K. This will vary some with source, condition, depth, and time in use.

1967-1008
KIRK, J. K.
Use of Poultry Litter as Animal Feed
Federal Register 32 (171): 12714-12715

A section (3.59) added to the Federal Food, Drug, and Cosmetic Act provides that whereas "poultry litter can be expected to contain drugs. . ." and "it is not feasible to estimate the nature and level of the drugs. . . it is not possible to conclude that poultry litter is safe as a feed or as a component of feed for animals. . .," and whereas poultry litter may transmit disease organisms, "therefore, the Food and Drug Administration has not sanctioned and does not sanction the use of poultry litter as a feed or as a component of feed for animals."

1967-1009
LACY, H. O.
Manure Disposal In Cage Houses
Canadian Poultry Review. Dec.
Reprint: Poultry Digest 27: 81-82 (1968)

Land spreading is considered to be the best means of disposal. The relative merits of dry shallow pits, wet shallow pits, liquid manure pumping, and plow-furrow-cover procedures are presented.

1967-1010
LANE, T. H.
Animal Waste Management and Utilization
Proc. Ontario Pollution Control Conf. p. 197-203

The major problems associated with animal waste disposal are excessive nitrogen and odors. Manure may be stored in pits until opportunity for spreading occurs or may be handled in anaerobic-aerobic or aerobic lagoons. Lagoons are a poor choice in Ontario. Composting or dehydration depend upon a non-existing market for their feasibility. Algae production with feeding of the harvested algae to livestock may have future potential. In summary,

"1. There is no economical way at present to treat fresh undiluted manure for disposal directly to streams.

2. Where adequate land is available, animal wastes can be used on the land.

3. Land spreading must be the method of ultimate disposal of animal wastes.

4. Soil application is the answer for the future whether the objective is utilization or disposal."

1967-1011
LEMAN, Allen D.

Poultry Litter as Protein for Ruminants
Feedstuffs 39: 8 Apr. p. 62

LEMAN reports satisfactory feeding results in Illinois, Arkansas, Virginia, and Minnesota. Before using litter as a feed, one should determine its continuous availability, get clearance from the local health service, contract for dry litter and other ingredients, and compare costs. Begin with small amounts watching closely for diarrhea and palatability problems.

1967-1012
LOEHR, Raymond C.
Effluent Quality from Anaerobic Lagoons Treating Feedlot Wastes
WPCF Jnl. 39: 384-391
Abst: C & S 67-0345; McQ & B B-070; W71-05423

The functioning of anaerobic lagoons is analyzed. Their performance depends on temperature, dilution by washwater or runoff, evaporation, seepage, and type and amount of loading. The process is essentially that of a septic or Imhoff tank.

Land disposal of the sediment is acceptable. It should, however, not be permitted to drain to streams without further treatment. "Anaerobic lagoons are not the complete answer to avoiding the pollution of natural waters by livestock and feedlot wastes. When used in combination with subsequent units to treat the effluent from the lagoons, anaerobic lagoons may be a useful component process for livestock and feedlot wastes that have a high solids content."

1967-1013
LOEHR, Raymond C.
The Impact of Animal Wastes on Water Resources Activities
Proc. 3rd Ann. Amer. Wtr. Res. Conf. p. 314-324
Abst: W69-02528

Pollution has been caused by animal wastes and animal production operations. Problems of proper handling of these wastes loom large in the future. A list of 28 references is included.

1967-1014
LOEHR, Raymond C. and AGNEW, Robert W.
Cattle Wastes -- Pollution and Potential Treatment
ASCE Proc. 93: SA 4: 55-72

Disc:	TAIGANIDES, E. Paul	94: SA 2: 435
	DAGUE, Richard R.	94: SA 2: 435-437
	BAFFA, John J.	94: SA 3: 558-559
	Closure	94: SA 6: 1287-1291

Abst: C & S 67-0344; McQ & B B-091; W71-04916

"While many possibilities for treatment and disposal of animal wastes exist, few are feasible or realistic." The authors advocate three lagoons in cascade: anaerobic, aerobic, and polishing. The feedlot should be diked to prevent inflow of surface runoff. The lagoons should have sufficient freeboard to hold storm runoff from the feedlot. The advantages cited are:

1. the cost of excavation and bottom sealing is moderate,

2. solids handling is simplified by having the upper lagoon adjacent to the feedlot,

3. sludge from the upper lagoon may be disposed of at the operator's convenience and by pumping as a slurry for field spreading,

4. lagoons may be sized for small area, as deep as possible (the aerobic and polishing lagoons should have small inflows),

5. the effluent should meet most stream quality standards or may be used for non-potable purposes, and

6. the runoff to streams is controlled, and occurs from the polishing lagoon.

In the discussions TAIGANIDES suggested that odor control problems "will limit the general application of the system proposed." DAGUE recommended the placing of a sedimentation basin ahead of the anaerobic lagoon, separation of manure and runoff, land spreading of sludge, and irrigation with the lagoon effluent. BAFFA proposed pumping to or from the lagoon to maintain optimum dilution.

1967-1015
McCARTY, P. L. et al [Task Group Report]
Sources of Nitrogen and Phosphorus in Water Supplies
Amer. Water Works Assn. Jnl. 59: 344-366

In this broad survey of the sources and quantities of nitrogen and phosphorus which reach surface or ground waters in the United States, farm animal wastes (p. 354) are cited in terms of population equivalents, and the contributions of nitrates to groundwater in the vicinity of feedlots is cited. The estimated 100 million wild waterfowl (p. 355) contribute 2 to 5 lb of nitrogen and 0.9 to 2 lb of phosphorus each per year. It is considered, however, that "while the activities of waterfowl may have a bearing on localized eutrophication, their actual net contribution of total nitrogen and phosphorus to waterways is perhaps negligible."

1967-1016
MINER, J. Ronald; FINA, L. R.; and PIATT, Cheryl
Salmonella infantis in Cattle Feedlot Runoff
Appl. Microbiol. 15: 627-628
Abst: C & S 67-0350; McQ & B B-349

Salmonella were identified in ten samples of runoff, loose dry litter, and compacted litter collected on or downstream of two experimental feedlots near Kansas State University. Agricultural runoff may be a source of *salmonellae* which would constitute a public health risk upon recreational use of the water.

1967-1017
OSTRANDER, Charles E.
Storage of Poultry Manure to Improve Flexibility of Handling (Abst)
Poultry Sci. 46: 1302-1303
Abst: McQ & B B-266

Spreading of manure should be timed to minimize neighbors' objections. Covered tanks with provision for thorough agitation are recommended. Addition of liquids may aid handling.

1967-1018
PATEL, Jawahar D.
Indian Utilizes Novel Manure Disposal System
Poultry Digest 26: 100-101

An anaerobic digester in a 20-ft-deep well 7 ft in diameter handles the waste from 500 chickens. It produces methane gas used for power and domestic cooking. The dried effluent is an excellent fertilizer inasmuch as it contains well-balanced nutrients, provides valuable humus, and has excellent storing qualities without deterioration.

For start-up a new digester requires "seeding" with the contents of an operating digester or a period of time for its own bed to become established.

1967-1019
PATRICK, Homer
New Way to S-t-r-e-t-c-h Litter
Broiler Industry, May
Reprint: Poultry Digest 26: 394-395

Litter built up by incremental additions works well for a while but it may develop worms and breeds of resistant coccidia. The author recommends composting to destroy microorganisms.

1967-1020
SALTER, P. J.; BERRY, G.; and WILLIAMS, J. B.
The Effect of Farmyard Manure on Matric Suctions Prevailing in Sandy Loam Soil
Jnl. Soil Sci. 18: 318-328
Abst: McQ & B B-134; W71-02034

To test the hypothesis that moisture conditions were likely to be more favorable for plant growth in a manured than in an unmanured soil, the authors measured reactions in both over a period of 24 weeks. They concluded that, although the differences were small, "the lower suctions prevailing in the manured soil could be a factor contributing to the higher yields of ryegrass obtained from the manured plots as compared with those obtained from the unmanured plots."

1967-1021
SMITH, Wade M., Jr.
Which Litter System is Best?
Poultry Digest 26: 200-202

"In the absence of a history of significant losses to specific viral or bacterial diseases, and in the absence of worm infestation, I would certainly give very serious thought to reusing old litter. . . It may be that composting old litter for a few days will help to minimize the potential problems with worm eggs, viruses and pathogenic bacteria."

1967-1022
STEPPLER, H. A. and LLOYD, L. E.
Pollution: Is Agriculture Culprit or Victim?
Agr. Inst. Rev. 22: Jan-Feb p. 26-27

The authors advocate a four-stage approach to the problem of agricultural pollution: 1) recognize the problem, 2) conduct research to define the problem, 3) conduct research to solve the problem, and 4) enact legislation to require acceptance of the solution.

1967-1023
STEWART, B. A.; VIETS, F. G.; HUTCHINSON, G. L.; and KEMPER, W. D.
Nitrate and Other Water Pollutants Under Fields and Feedlots
Environ. Sci. and Tech. 1: 736-739
Abst: McQ & B B-108; W71-03575

Core samples taken in the South Platte Valley of Colorado indicate that nitrate is being carried to the water table. Average total nitrate-nitrogen content to a depth of 6.7 m for various types of land use was reported to be: alfalfa, 70; native grassland, 81; cultivated dryland, 233; irrigated fields not in alfalfa, 452; and feedlots 1282 kg/hectare.

"The findings that water under feedlots frequently contained ammonium [or a compound releasing ammonium] and organic carbon, and had a very offensive odor cause further concern about the effect of feedlots on underground water supplies."

1967-1024
STRAUB, Charles
Feedlot Under Roof
Farm Qtrly. 22: Spring p. 74, 75, 100, 102
Abst: McQ & B F-024

In a report oriented toward feeding gains and labor saving rather than manure handling, several confinement buildings in the Corn Belt are described. Manure from pits under a slatted floor may be removed a few times a year. However, this task can become unpleasant "when the stinking stuff gets in a semisolid form and refuses to cooperate with the pump."

1967-1025
TAIGANIDES, E. Paul
Farm-Waste Management in Europe and India
Agr. Engrg. 48: 710-713 [ASAE Paper 66-930]
Abst: McQ & B B-633, G-021

European and Indian practices which might well receive study in the United States are discussed under five headings:

(1) Spreading by Irrigation. India mixes sewage and manure, then pumps the mixture to fields for irrigation-fertilization. Reuse of municipal effluent is common.

(2) Oxidation Ditches. Holland is successful with combined sewage and dairy plant waste water. More research is needed for treatment of manures.

(3) Digestion of Waste With Gas Utilization. Germany installed many plants after World War II. Most have been abandoned because of maintenance problems. India has about 2000 digesters and is planning to add 9000 more in the next four years.

(4) Composting. May merit study.

(5) Algae Production and Utilization. Little effective precedent in India. Better management seems to hold promise.

1967-1026
ANON

Cattle Wastes
Effluent and Water Trtmt. Jnl. 7: 549

Research at the University of Kansas has indicated the effectiveness, technically and economically, of a series of three lagoons for treatment of cattle wastes. The first lagoon is anaerobic. Its small quantity of highly-potent effluent is treated in an aerobic lagoon. The third lagoon, also aerobic, polishes the effluent from the second.

1967-1027
ANON
Canadians Explain Advantages, Problems in Feeding Poultry Litter
Feedstuffs 39: 7 Jan. p. 46

Poultry litter analyzed at the University of Alberta had ranges in water content from 9.4 to 18.7 percent, in protein of 13.0 to 29.6 percent, in crude fiber of 6.7 to 22.4 percent, in calcium of 1.05 to 2.33 percent, in phosphorus of 0.59 to 1.79 percent, and in nitrate of 0.08 to 0.97 percent. Rather extensive use is made of litter in cattle rations in Alberta. "The enthusiasm for feeding litter comes from the decreased cost of the ration rather than from the increased gains." Problems encountered in the feeding of litter are heating (with resultant loss in nutritional value) during storage, cost of litter and of mixing in small batches, dustiness, digestive disorders, scrap metal in the litter, odor, and public aversion.

1967-1028
ANON
Poultry Litter Feed not FDA-Sanctioned
Feedstuffs 39: 9 Sept p. 1, 71

The FDA has proclaimed poultry litter to be unacceptable for use as an animal feed because of its possible content of antibiotics fed the chickens to stimulate growth and/or combat disease. It is considered to be impractical to determine or estimate the amounts present. In addition, chickens can transmit diseases to humans, cattle, and other animals.

1967-1029
ANON
Farm Wastes
Munic. Jnl. 75: 2889

Solutions proposed for the problems of manure disposal in the UK could well "be the provision of a subsidy for spreading slurry, or the complete removal of subsidies on present fertilisers." Much marginal land exists which is "crying out for cheap fertilisers."

"If the Ministry of Agriculture could provide some incentive to the farmer to utilise the wastes from livestock, his own and his neighbours, as well as sewage works sludges, we are likely to find the problem diminishing."

1967-1030
ANON
Breathing Manure Dust May Cause Illness
Missouri Egg and Poultry News April
Reprint: Poultry Digest 26: 336

Poultry specialists at the University of California recommend that a filter respirator, capable of removing airborne bacteria, be worn whenever dry, dusty poultry manure is to be handled. Fever and influenza-like symptoms have occurred following operations of hammer mills grinding such manure.

1967-1031
ANON [Based on William J. TOLEMAN]
Manure Handling Labor Studies
Pacific Poultryman, Oct.
Reprint: Poultry Digest 27: 39 (1968)

The labor required to handle the manure output of 1000 hens per year is reported to be 104 hours for hand shoveling with transportation in a wheelbarrow to a manure spreader. Mechanical systems listed have values ranging from 26 hours for daily scraping of cages to 4.5 hours for cleaning a deep "dry" pit by a tractor with a front-end loader driven into the pit.

1967-1032
ANON
Farm Wastes: Research into Disposal
Surveyor 130: 9 Dec p. 36

An inquiry in Parliament brought the responses that the Water Pollution Research Laboratory of the Ministry of Technology had done some work on animal wastes. The Scots were reported to be studying oxidation ditches and anaerobic digestion of poultry wastes.

1968-1001
ABBOTT, J. L. and LINGLE, J. C.
Effect of Soil Temperature on the Availability of Phosphorus in
Animal Manures
Soil Science 105: 145-152
Abst: McQ & B B-159; W71-06455

"This study evaluates common manures applied to the soil in terms of their ability to supply available P to plants. . . On an equal dry-weight basis, the overall effectiveness of manures in supplying available P depended on their respective total P contents: poultry > sheep > steer = dairy."

1968-1002
ALEXANDER, D. C.; CARRIÈRE, J. A. J.; and McKAY, K. A.
Bacteriological Studies of Poultry Litter Fed to Livestock
Can. Vet. Jnl. 9: 127-131

"Experiments were undertaken to determine if pathogenic bacteria are present in poultry litter being fed to livestock in Canada, and to determine the survival time (viability) of these bacteria which are known to be the cause of animal diseases."

Findings indicate that one to two months storage may be sufficient to destroy salmonella. "In the future it may be shown that litter could be seeded with beneficial bacteria during a holding period to decompose the litter material, thereby increasing the feeding value and at the same creating an unfavorable environment for the survival of pathogenic bacteria." Some species of bacteria remained viable in sterilized litter much longer than they would have in unsterilized due to the elimination of competitors.

1968-1003
ANTHONY, W. Brady
Wastelage -- A New Concept in Cattle Feeding (Abst)
Jnl. Animal Sci. 27: 289
Abst: McQ & B B-209

Fresh manure from full-fed slaughter cattle was blended with ground hay in the ratio 57:43, then stored in silos. In two feeding trials cattle fed wastelage (up to 40 percent) outgained cattle fed corn silage. "Wastelage should not be stored in a rusty structure."

1968-1004
BAY, Ovid
How to Handle Feedlot Runoff
Farm Journal 92: Feb p. 62A-62B

Water pollution from feedlots can be stopped by use of lagoons with dikes enclosing feedlot and lagoon to prevent inflow. Evaporation or pumping for irrigation prevents lagoon overflow. When the lagoon is dry, solids may be hauled to the field. Examples are cited from Kansas and Colorado. Sale of manure with a charge of 25 ¢/ton for loading and 3 ¢/ton-mile for delivery is cited.

1968-1005
BEEBY, L. D.
Management and Feeding in the Beef Cattle Feedlot
Agric. Gaz. of New South Wales 79: 386-392

This brief guide to feedlot practice under Australian conditions contains the following advice: "The manure problem remains unresolved. Manure should be scraped out of the yards at least at the end of each batch of cattle. The spreading of this manure on pastures, using a manure spreader, would be the best method of handling it. There appears to be no market for manure."

While it is emphasized that the lot should be well drained, no mention is made of pollution caused by runoff.

1968-1006
BENDER, D. F. and PURCELL, T. C.
Reclamation of Valuable Compounds from Agricultural Refuse and Municipal Waste
Conf. "Solid Waste Research and Development, II." Preprint No. E-3 2 p.

The authors are studying the feasibility, in terms of reduced cost of disposal if not of net profit, of salvaging valuable compounds from chemical processing of waste -- as is done effectively in the petrochemical industry. Incinerator effluents, fly ash in particular, seem promising.

1968-1007
BRATZLER, J. W. and LONG, T. A.
Digestion of Hydrolyzed and Cooked Poultry Waste by Ruminants (Abst)
Jnl. Animal Sci. 27: 1509
Abst: McQ & B B-214

Lambs fed diets in which nitrogen was supplied as soybean meal, hydrolyzed poultry waste, and cooked poultry waste had digestion coefficients for dry matter of 75.3, 72.1, and 76.1 percent respectively; for protein of 74.3, 65.5, and 69.4 percent; and energy 74.7, 73.5, and 76.3 percent. "None of the differences due to treatment were found to be significant."

1968-1008
BRUGMAN, H. H.; DICKEY, H. C.; PLUMMER, B. E.; GOATER, J.; HEITMAN, R. N.; and TAKA, M. R. Y.
Drug Residues in Lamb Carcasses Fed Poultry Litter (Abst)
Jnl. Animal Sci. 27: 1132
Abst: McQ & B B-210

Lamb feeding tests at the University of Maine indicated that Ampro-Plus and 3-Nitro impair the growth of smaller lambs but not of larger lambs. With ampro and arsenic present in the litter, none was found in the carcass.

1968-1009
BULLARD, W. E., Jr.
Natural Filters for Agricultural Wastes
Soil Conservation 34: 75-77
Abst: W71-00940

Spray irrigation of diluted wastes over wide expanses of land permits the natural system of nutrient breakdown for re-availability to crops to operate.

1968-1010
CARRIÈRE, J. A. J.; ALEXANDER, D. C.; and McKAY, K. A.
The Possibility of Producing Tuberculin Sensitivity by Feeding Poultry Litter
Can. Vet. Jnl. 9: 178-185

Poultry litter may contain mycobacteria which, even when not pathogenic for cattle, could induce false positive tuberculin sensitivity. Such bacteria can survive in poultry litter for at least a month when competing with the microflora of the litter. Heating of the litter can kill competitors and extend the viability of mycobacteria for two months longer.

1968-1011
CHALOUPKA, G. W.; LLOYD, R. W.; GORDY, J. F.; and GREENE, L. M.
Observations on the Effect of the Re-Use of Broiler Litter on the Incidence of Marek's Disease (Abst)
Poultry Sci. 47: 1660
Abst: W71-04927

Chickens raised on re-used litter are less likely to be condemned for Marek's disease than are chickens raised on fresh litter.

1968-1012
DALE, A. C.
Disposal of Dairy Cattle Wastes by Aerobic Digestion
Conf. "Solid Waste Research and Development, II." Preprint No. D-6. 2 p.
Abst: C & S 68-0276

Aerobic digestion of dairy cattle waste is being studied in the laboratory and in the field at Purdue. "From the field studies, the conclusion seems quite evident that odors can be almost eliminated by the use of aeration. However, degradation appears to go slowly."

1968-1013
DAY, D. L.; JONES, D. D.; and CONVERSE, J. C.
Field Testing the Oxidation Ditch for Swine Waste
Conf. "Solid Waste Research and Development, II." Preprint No.
E-4. 3 p.
Abst: C & S 68-0279

Pasveer ditches as treatment devices for animal wastes are in an early phase of research development. As a stage following screening and prior to some additional polishing of the effluent if it is to be discharged to a stream, the ditch would appear to hold much promise. Studies continue at the University of Illinois.

1968-1014
DUGAN, Gordon L.; GOLUEKE, Clarence G.; and OSWALD, William J.
Photosynthetic Reclamation of Agricultural Solid and Liquid Wastes
Conf. "Solid Waste Research and Development, II." Preprint No.
E-1. 4 p.
Abst: C & S 68-0280

The objective of a study underway at the Sanitary Engineering Research Laboratory of the University of California is "to convert a large fraction of the agricultural wastes now causing severe environmental problems such as odor, unsightliness, and fly breeding into reclaimable material. The project will involve a detailed study of the basic characteristics of an integrated anaerobic fermentation and algal growth system for agricultural solid and liquid wastes on a small pilot plant scale. To be studied are the reaction kinetics and overall performance of an anaerobic reactor or pond followed by an algal growth reactor or pond. Recirculation of algal-free effluents will be employed for odor control in the anaerobic pond and for nutrient transmission into the algal growth pond. Area and volume requirements per unit weight of waste and waste yields of algae per unit weight of waste will be determined."

An early finding is that the treatment plant should be located near the source of manure. The fresher, the better.

1968-1015
EL-SABBAN, F. F.; LONG, T. A.; FREAR, D. E. H.; and GENTRY, R. F.
Composition of Broiler and Laying-House Litters (Abst)
Jnl. Animal Sci. 27: 1509-1510
Abst: McQ & B B-215

Analyses of 60 samples of litter are reported. Crude protein averaged 24.83 percent (dry basis). "Broiler house litter (BHL) had significantly higher values for crude protein, ether extract, and crude fiber than laying house litter (LHL). Total ash was higher in LHL than in BHL. LHL had significantly higher content of Ca, P, K, Mg, Fe, Al, and Zn. BHL had higher Na and Cu contents than did LHL. The average arsenic content in BHL was lower than in LHL, 11.0 ppm as compared to 29.0 ppm." Many factors affect the values.

1968-1016
GERRY, R. W.
Manure Production by Broilers
Poultry Sci. 47: 339-340
Abst: McQ & B B-268; W71-07541

Figures in the literature for the amount of poultry manure vary considerably. In some cases lighter fowl and longer feeding periods than are customary in commercial practice are reported. A test with broilers raised to 53 days of age resulted in 867 kg dry excreta per 1000 males and 658 kg per 1000 females. Total litter removed was 1707 kg and 1476 kg in the two cases.

1968-1017
GIBBONS, J.
Farm Waste Disposal in Relation to Cattle
Water Pollut. Control 67: 622-626 Disc.: 638-643
Abst: C & S 68-0283; McQ & B A-285; W70-06591

With increasing size of herds manure handling is becoming a serious problem. Solutions suggested include "organic irrigation" in which all excreta is washed into a holding tank with at least ten days capacity. The slurry is pumped from the tank, usually once a week, to a rain-gun for land distribution. This is effective provided:

(1) Adequate acreage is available within reach of the equipment,

(2) 0.33 to 0.5 acres per cow are available,

(3) The soil is reasonably free-draining so that the liquid infiltrates rather than runs off,

(4) The field is well isolated, and

(5) Care is taken to avoid supersaturation and wind carriage of spray and odor.

Spreading by a vacuum tank involves use of heavy equipment on the land, and thus requires storage capacity to carry through wet weather or frozen ground.

Silage effluent requires dilution and spreading to avoid "burning" of vegetation.

1968-1018
GRUB, W.; ALBIN, R. C.; WELLS, Dan M.; and OWENS, T. R.
Feedlot Design and Management for Pollution Control
Texas Tech ICASALS Spl. Rpt. No. 7 p. 35-42

Stabilization in a manure pack is limited by lack of moisture or low temperature. When remoistened, dry manure regains its pollutional potency.

A feedlot should be designed in such a way that no surface water flows into the lot or from one pen to another within the lot. Runoff should be detained in a pond and not allowed to reach the natural drainage courses. Ideally, such a pond would provide aerobic decomposition. Practically, in an arid area particularly, evaporation and seepage may empty the pond before much treatment occurs.

Pond water, diluted from some other source, may be used for irrigation.

1968-1019
GRUB, W.; ALBIN, R. C.; WELLS, Dan M.; and WHEATON, R. Z.
A Report on the Engineering and Biological Aspects of Cattle Feedlot
Runoff Pollution Control
Texas Tech iii + 23 p. processed

This is a report of an investigation of the effects of ration on quantity and composition of wastes, of the pollutional character of runoff, and of the possible methods of control to prevent pollution of surface waters. "It was concluded that the only practical way of controlling pollution resulting from feedlot runoff is to provide facilities for retaining the runoff that occurs. If land is available, the accumulated runoff can be utilized as irrigation water, or the land may be utilized simply as the final step in treatment and disposal of the waste. If no land is available for final disposal, retaining ponds must be sufficiently large to allow accumulated liquid runoff to evaporate."

1968-1020
HARMS, Robert H. and AMMERMAN, C. B.
Feeding Value of Poultry Litter Containing Citrus Pulp for Ruminants
Feedstuffs 40: 7 Sept p. 21-22
Abst: McQ & B F-098

The authors review the literature on the relative merits of various litter materials, observing that increased demand and increased difficulty of disposal would seem to indicate investigation of an unconventional litter with further reuse value. Tests indicated "that poultry litter containing citrus pulp is an excellent feedstuff for use in ruminant feeding." While citrus pulp meal is toxic to chicks when it exceeds about 30 percent of the diet, this is not considered to be an actual problem. FDA restrictions would prevent such use at present.

1968-1021
HART, Samuel A.
Agricultural Waste Management in the Future
Agr. Engrg. 49: 729, 752 [ASAE Paper 67-933]
Abst: C & S 68-0287; McQ & B B-635, G-034

"The real limitation in manure management today is economics." Odor control remains to be solved.

1968-1022
HOWES, J. R.
Management and Utilization of Poultry Wastes
Feedstuffs 40: 14 Dec. p. 22-23
Abst: McQ & B F-099

Uses suggested in a series of diagrams include illicit alcohol, feed to poultry or animals, incinerate, sanitary landfill, land spreading as a crop fertilizer, composting for animal feed or for fertilizer, and algal recycling. Not all are discussed in the text. ". . . waste disposal can be turned into waste utilization with proper management."

1968-1023
HOWES, J. R.
The Digestion of Poultry Feces Under Cages (Abst)
Poultry Sci. 47: 1682
Abst: McQ & B B-269; W71-04929

"After an initial buildup period, the feces and substrate was inoculated with aerobic bacteria and aerobic conditions maintained by disturbing the surface cake at weekly (winter) or twice weekly (summer) intervals. . Odors and flies have been largely eliminated. . . The bulk of the fecal pile was less than half the volume of the control plots due to stabilization of nitrogen and water losses. Feathers were digested if they were incorporated into the fecal pile and the resulting material was a homogeneous, odorless fertilizer which has been used in urban gardens. . ."

1968-1024
JONES, Don D.; JONES, B. A., Jr.; and DAY, Donald L.

Aerobic Digestion of Cattle Waste
ASAE Trans. 11: 757-761 [ASAE Paper 67-931]
Abst: McQ & B B-030, G-032; W71-03576

The governing equation for aerobic biological growth is

$$\text{organic matter} + O_2 + NH_3 = \text{sludge cells} + CO_2 + H_2O.$$

That for aerobic digestion is

$$\text{sludge cells} + O_2 = CO_2 + H_2O + NH_3.$$

A laboratory study of digestion of wastes from dairy and beef cattle is described. It was concluded that less emphasis should be placed on COD, VS, and FS and that more should be placed on BOD as a measure of pollutional strength.

1968-1025
KIMBARK, John
Deep Manure Pit Kills Cage House Odors
Pennsyl. Farmer 10 Feb.
Reprint: Poultry Digest 27: 254-255

A deep dry pit with adequate ventilation is expected to serve six years between cleanings. Flies present no problem "and rat poison dropped into the pit provides control of these pests." Drinking water is made available to the hens only during limited periods each day.

1968-1026
LOEHR, Raymond C.
Anaerobic Lagoons: Considerations in Design and Application
ASAE Trans. 11: 320-322, 330
Abst: McQ & B B-026; W71-08220

An anaerobic lagoon may function as a primary sedimentation tank with the solids left in the unit to degrade until removed periodically -- usually when field spreading is convenient.

A deep tank with a small surface area is preferable. A detention time of three to five days may be sufficient. The scum cover which usually forms is beneficial. Alkalinity, pH, temperature, and mixing are more important than rate of loading. A balance should be maintained between acid forming and methane forming bacteria by adding alkalinity as needed and cushioning abrupt changes.

Seepage should be prevented. Disposal of effluent and solids is required, and noxious odors can occur when the balance is disturbed.

1968-1027
LOEHR, Raymond C.
Pollution Implications of Animal Wastes -- A forward Oriented Review
USDI. FWPCA Ada, Okla. x + 175 p.
Reprinted as EPA Water Pollution Control Research Series 13040---07/68
June 1973
Abst: C & S 68-0294 [Separate chapters C & S 68-0295 through -0301];
McQ & B A-311

This excellent state-of-the-art survey of the pollutional implications of animal wastes as evaluated in 1967 should be read in its entirety by any serious student of the subject. LOEHR summarized his recommendations on p. vii - x, and stated his conclusions and recommendations as part 9 (p. 151-161). Supporting material, bolstered by 141 references, appears in the first eight parts, each of which has its own summary. These parts are entitled

1.	Reasons for the study	Page 1
2.	Introduction	3
3.	Trends in animal production	9
4.	Manure production	24
5.	Pollution hazards	54
6.	Waste treatment and disposal	69
7.	Costs	110
8.	Legal	145

Two pertinent quotations from the summary of Part 6 follow: "The entire problem of the ultimate disposal of solids remains untouched. Land application of waste liquids and solids has been used for centuries but few data have been accumulated on the optimum amounts of material that can be placed on the land, on proper management techniques, on land disposal of wastes with different qualities, on subsequent pollution that may occur, and on changes in soil conditions that may result. Major emphasis to date has been on crop response which, while valuable, provides little information on disposal techniques."

"At present, there is no profitable method of livestock manure utilization and it is unlikely that one will be developed. Animal waste handling, treatment, and disposal will cost something. This must be made clear to those that produce the animals and the public that consumes them. The cost of satisfactory waste treatment will be related to the desires of the public to minimize pollution from these sources, to the willingness of the consumer to accept higher meat prices to pay for the treatment, and to the ingenuity of those in all professional disciplines in developing suitable treatment systems."

1968-1028
McDONALD, R.
Disposal of Poultry Manure
Scottish Agric. 47: 91-93
Abst: McQ & B E-058

Methods discussed are:

1. The Deep Pit System. A depth of 6 ft, 6 in, with cleaning at annual intervals or longer is common. Forced ventilation carries the animals' heat over the manure for drying.

2. Fresh Manure from Laying Battery Cages. Provide a chute to a honeywagon and spread frequently. Trouble-prone.

3. Hydraulic Disposal. A vacuum tanker and/or pipeline may be used. Excess weight must be handled, odor problems arise, and land must be available.

4. Poultry Lagoons. Used in U. S. A. in temperate climates. Doubtful value in Scotland.

5. Oxidation Ditch ('Pasveer' System). Little experience yet, but promising.

6. Anaerobic Digestion under Control. Not perfected for general use yet.

7. Drying. Successful for large producers. High capital costs.

8. Disposal into Main Sewers. Permission is required. Slug flow must be avoided.

1968-1029
McGAUHEY, P. H. (Chairman)
Solid Wastes Research and Development, II
Conference Preprints, Wayland Academy, Beaver Dam, Wisc. No page numbering.

This volume contains summaries of 59 papers classified under the subheadings of

A. Storage, Collection and Transportation of Solid Wastes
B. Sanitary Landfill
C. Incineration
D. Composting
E. Agricultural and Industrial Solid Wastes
F. Management and Planning of Solid Waste Systems
G. Training
H. Special Solid Waste Research

Many papers oriented toward municipal solid waste practices may well carry valuable considerations for animal waste disposal as well. Six particularly pertinent papers are abstracted separately in this volume [1968-1006, 1012, 1013, 1014, 1037, and 1044].

1968-1030
McLAREN, G. A. and BRITTON, R. A.
Ruminant Digestibility of Re-Fed Hemicellulose Fractions (Abst)
Jnl. Animal Sci. 27: 1515

Lambs were fed a commercial high-energy diet with roughage consisting of ground corn cobs or wheat straw. The undigested fiber fraction from the feces on the first trial was recovered and refed at the same level as the original roughage. Performance on the two roughages differed significantly. For the corn, of which 10.66 percent consisted of acid resistant hemicellulose (ARH), 75.5 percent of the acid hydrolyzable hemicellulose (AHH) and 83.3 percent of the ARH was digested on the first feeding. The figures were 9.5 percent of AHH and 43.4 percent of ARH on refeeding. For the chopped wheat straw, of which 3.45 percent consisted of acid resistant hemicellulose the percentages digested on first feeding were 65.4 (AHH) and 40.9 (ARH). Those on refeeding were 9.8 (AHH) and 35.1 (ARH).

1968-1031
MINER, J. Ronald
Agricultural (Livestock) Wastes [In WPCF 1967 Literature Review]
WPCF Jnl. 40: 1150-1158

Three major symposia on animal wastes have been held to date: the National Symposium on Poultry Industry Waste Management, the Second National Symposium on Poultry Industry Waste Management and the National Symposium on Animal Waste Management. All three were sponsored by the ASAE, the first two in cooperation with the Poultry Science Association.

Papers are reviewed briefly under the following classification scheme. Superscripts key them to the 71 references listed.

- Pollution Control and Abatement
- Waste Characteristics
  - General
  - Odors
  - Pathogenic Organisms
- Treatment Schemes -- Laboratory Studies
  - General
  - Oxidation Ditch
  - Anaerobic Lagoons
  - Land Application
  - Operating Experiences

1968-1032
PONTIN, R. A. and BAXTER, S. H.
Wastes from Pig Production Units
Water Pollut. Control 67: 632-638 Disc. 638-643
Abst: C & S 68-0303; McQ & B A-284, A-510; W71-05428

Disposal of untreated slurry on land produces objectionable odors and possible health hazards. Composting first is desirable.

Treatment by lagoons, anaerobic digestion, biological filtration, and several versions of activated sludge methods is discussed.

"A digester in continuous operation for 1000 pigs could be expected to produce 10,000 cu ft of methane per day, equivalent to 6.5 million BTU. Of this, 75 percent would be available for useful power, the remainder being used to maintain the temperature at 35°C."

Biological filtration is expensive. Tests on a Pasveer oxidation ditch are described in detail. "However, precise design figures have yet to be obtained, and it is essential that interested parties should lose no time in initiating research to that end."

1968-1033
RILEY, Charles T.
A Review of Poultry Waste Disposal Possibilities
Water Pollut. Control 67: 627-631 Disc. 638-643
Abst: C &S 68-0305; McQ & B A-283, A-512; W70-06590

Waste from laying hens "has higher NPK values than any other agricultural waste but, because it is sticky and difficult to handle, it is the least appreciated." Properties are discussed. Usual disposal is to land. Odors may create problems.

Eight different makes of heat dryers are available on the UK market. Lack of marketing experience may be slowing adoption of drying. Based on cash return the most promising markets are (1) home gardens; (2) mushroom composting, hop growing, and animal and fish feeding, and (3) bulk sales to agriculture, horticulture or industry.

Traditional sewage disposal methods are unsuitable for poultry manure.

Animal feeding "might achieve a greater prominence in the future, but the quality of the litter and questions of disease control and transmission within animals would be of great importance."

1968-1034
SINGH, Y. K. and ANTHONY, W. Brady
Yeast Production in Manure Solubles (Abst)
Jnl. Animal Sci. 27: 1136
Abst: McQ & B B-211

Manure from the pen floor of concentrate-fed cattle was separated into solubles and fiber. The solubles were inoculated with yeast, incubated and dried. The crude protein of the final yeast product was 40.9 percent, dry basis. "The solubilized product was 11% sugar. Rats fed the dried solubles developed diarrhea which was attributed to the high mineral content of the product. This study shows that yeast can be grown in the soluble portion of manure and that about 68.57% of the manure dry matter can be recovered as solubles."

1968-1035
SMITH, George R. and ABBOTT, F. DeWitt
Ponds Stop Pollution from Feedlots
Soil Conservation 34: 78-79
Abst: W71-00925

An installation at Oakley, Kansas, of a feedlot with a detention pond complying with Kansas regulations is described and illustrated. With an annual precipitation of 18 inches, evaporation will usually be sufficient to remove the effluent. It can, however, also be used for irrigation.

1968-1036
TAIGANIDES, E. Paul
Animal Waste Disposal Methods -- Present and Future
Feedstuffs 40: 14 Sept p. 37, 40

Animal wastes are neither fluid enough to be pumped, nor dry enough for bulk transport. Addition of water or bedding increases volume to be handled. Manure is non-competitive as a fertilizer, but has value as a soil conditioner. Present disposal methods, discussed briefly, include anaerobic lagoons, anaerobic digestion with production of methane gas, oxidation ditches, hydration, coprophagy, composting, and field spreading. In the next five to ten years improvements can be anticipated to reduce labor, nuisance, and unsanitary practices. The total system should be optimized in selecting a disposal procedure.

1968-1037
TAIGANIDES, E. Paul
Engineering Properties of Farm Wastes
Conf. "Solid Waste Research and Development, II." Preprint E-5 2 p.
Abst: C & S 68-0310

"The recent trends in animal production are changing the animal waste Generation pattern from diffused. . .to point-source, Transport from solid to liquid handling, Processing from simple storage to rigorous treatment, Utilization from crop fertilizer to soil conditioner, and Disposal from a chore to a vexing problem."

"The wastes are not fluid enough to be pumpable by conventional pumps, nor to decompose without putrefaction, nor are they dry enough to be transportable as bulk materials, nor to be odor free."

1968-1038
TOENJES, Don and FOWLER, Bob
Settling Basin Sorts Out the Sludge
Farm Journal 92: Oct p. 54

With $200 worth of concrete a California dairyman built a settling tank with three screens to replace an open ditch. Liquid flows off in a pipe for irrigation. The sludge, which drains as it dries, is removed every six weeks.

1968-1039
UNDERWOOD, Clarence
Irrigating with Animal Waste
Soil Conservation 34: 81-82
Abst: W71-00941

An installation in eastern Oregon in which effluent from a second lagoon on a hog farm is used to irrigate cropland by spray irrigation is described and illustrated. No further fertilizer is required.

1968-1040
VAN DAM, J. and PERRY, C. A.
Manure Management -- Costs and Product Forms
Calif. Agr. 22: Dec. p. 12-13
Abst: McQ & B E-111; W71-02037

Costs of manure handling are tabulated and discussed for a 14,000-head feedlot in Los Angeles County. Mounding in the corral and removing to a compost stockpile costs 25 ¢/cu yd. With hand-labor on the places inaccessible to bulk handling, this becomes 39.2 ¢/cu yd. The manure is cured six months before processing. Costs if marketed unprocessed are 10.5 ¢/cu yd, if marketed composted in bulk are 65 ¢/cu yd, and if packaged in paper bags of 2 cu ft capacity are $1.88/cu yd.

1968-1041
VAN DAM, J. and PERRY, C. A.
Manure Management, Costs and Product Forms
Compost Sci. 9: Summer p. 26-27
Abst: C & S 68-0314

A Los Angeles County beef-producing feedlot prepares manure for marketing in three basic forms ranging from unprocessed to "composted, packaged" and sells, at a profit, on four pricing conditions. Costs are tabulated.

1968-1042
WADLEIGH, Cecil H.
Wastes in Relation to Agriculture and Forestry
USDA Misc. Pbln. 1065 112 p.
Abst: C & S 68-0315; McQ & B E-085

This well written and well documented (139 references) survey points up the inadequacy of present knowledge to deal economically with animal wastes. More research is needed. With concentrations of animals and with economies of production of fertilizers from atmospheric nitrogen, manure has passed from a valuable commodity to a nuisance of which the cost of transportation exceeds the value as fertilizer. Lagoons provide a questionable alternative means of disposal since they are often plagued by overloading with attendant conversion from an aerobic to an anaerobic condition, floating litter, intermittent operation, aquatic weeds, and sludge buildup.

Possibilities meriting further study include that of using livestock and poultry wastes as a culture medium for the propagation of organisms antagonistic to known plant pests and diseases and that of combining agricultural and industrial wastes as an effective soil amendment.

1968-1043
WARE, L. M. and JOHNSON, W. A.
Poultry Manure for Vegetable Crops -- Effects and Value
Alabama Ag. Ex. Sta. Bull. 386. 31 p.
Abst. McQ & B E-121

When applied to tomatoes, collards, turnips, and lettuce in controlled experiments broiler manure gave substantial increases in yield. Soil acidity with manure but without fertilizer remained essentially constant. With fertilizer but without manure it increased with time. The effect on earliness was not consistent. Cracks and culls did not increase percentagewise, and there was little change in size of vegetable. Weather had a marked effect on production. Increased value of the tomato crop was cited as $448 per ton of manure at optimum rate of application.

"Certainly the potential value of the manure produced by the poultry industry of Alabama is too high to allow this product to go to waste or to constitute a disposal problem, although the returns may be far less than those reported in this study."

1968-1044
WITZEL, S. A.; POLKOWSKI, L. B.; McCOY, E.; ATTOE, O. J.; and
CRABTREE, Koby
Farm Animal Waste Disposal Research at the University of Wisconsin
Conf. "Solid Waste Research and Development, II." Preprint No. E-2 4 p.
Abst: C & S 68-0328

Anaerobic storage of manure is effective in preserving its fertilizing value and reducing pollutional potential. Liquid from piled manure should be captured. Manure should not be applied to frozen ground; the runoff from snow melt carries much of the nitrogen and phosphorus into streams. Excessive applications of nitrates may affect groundwater.

1968-1045
ANON [Based on L. R. WEBBER]
Animal Waste Utilization Group Formed in Canada
Compost Sci. 9: Autumn p. 17-18
Abst: C & S 68-0271

A committee, chaired by Dr. WEBBER, has set a 7-point objective for study and proposals for action in Canada. The projects to be covered are:

A. Livestock density and land for disposal inventory,
B. Area of future development prognostication,
C. Economic study of manure handling practices,
D. Odor control processes,
E. Health problems -- human and animal,
F. Management practices with adequate land for spreading, and
G. Management practices with inadequate land.

1968-1046
ANON
Plow-Furrow-Cover Mode of Manure Removal Near
Egg Industry v. 1, Nov. p. 24

Charles H. REED, of Rutgers, has perfected a plow-furrow-cover method of manure disposal which, in experiments, has permitted the disposal of 170 to 225 tons of manure per acre without odor. The liquid manure is distributed from a tank into a 6 to 8 inch deep furrow and covered in the same or a subsequent operation.

1968-1047
ANON
Midwesterner's Goal: Make Manure Pay
Egg Industry v. 1, Nov. p. 26-27

An egg producer near Chicago with 80 tons of hen manure production per day has, by using a 350,000-gal tank, been disposing of the manure on a 20-acre plot. Use as a fertilizer on corn and pea cropland on rented property being held for ultimate suburban development is contemplated.

1968-1048
ANON [Based on Cecil H. WADLEIGH]
Waste Problems of Agriculture and Forestry
Envir. Sci. and Tech. 2: 498-503
Abst: C & S 68-0316

This summary of USDA Misc. Pbln. 1065 [1968-1042] points up the necessity for study on characteristics of manures; removal from livestock quarters; storage; transport; feasibility of use on land; and disposal by burning, lagooning, burying, or other methods.

Specific research goals cited are to:

(1) Identify and destroy odor-producing bacteria present,
(2) Treat manure to make it less attractive to flies and vermin, and
(3) Develop better procedures for application to cropland, avoiding odors and water pollution in the process.

1968-1049
ANON [Based on David C. LUDINGTON]
No Panacea for the Poultry Waste Problem
Poultry Digest 27: 459

LUDINGTON is quoted as favoring dry manure handling on the basis of odor control. Subsurface injection is advocated where land spreading would cause air or water pollution. "Touching on various other disposal processes, such as incineration, dehydration and biological treatment, LUDINGTON said there are no disposal processes available today that are economical enough to be justified except land application."

1968-1050
ANON
Cattle Feeders Avoid Pollution by Using Wastes in Irrigation
Soil Conservation 34: 84-86
Abst: W71-00939

Operation of a feedlot at Upland, Nebraska, in which effluent is detained in a pond then pumped for spray irrigation of corn is described and illustrated. Pond water is diluted by pumping groundwater into the pond as necessary.

1969-1001
ALLEE, David J. and CLAVEL, Pierre
Who Should Regulate Poultry Conflict Problems?
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 407-414
Abst: McQ & B C-139; W71-02747

Compromise as good neighbors is considered preferable to regulation. In rural areas such an atmosphere is often created by informal industrial committees cooperating with the county agent. The agricultural establishment, having the technical expertise, is in a better position to assure reasonable performance than is county or state government.

1969-1002
ANTHONY, W. B.
WASTELAGE -- Something New in Cattle Feeding
Highlights of Agric. Rsch. 16: Summer 1 p.

Performance of ewes, heifers, and steers on tests of 389, 332, and 126 days respectively are described briefly. "At the end of the study, the wastelage-fed ewes were more vigorous and appeared healthier than the hay-fed ewes." The wastelage-fed pen of steers gained 2.57 lb per day; those on standard ration gained 2.42. "Of utmost importance is that manure fed to cows is fermented by rumen microbes so that it is changed into the usual products of digestion, just as conventional feeds. Not only do the rumen microbes change the products of manure, but they prevent the growth of harmful bacteria in the rumen."

1969-1003
ANTHONY, W. Brady
Cattle Manure: Re-Use Through Wastelage Feeding
Cornell Univ. Conf. on Agric. Waste Mgmt. p. 105-113
Abst: McQ & B C-107; W71-02715

"Organic waste from cattle reared in confinement can readily be eliminated as a noxious pollutant and converted to a valuable feed for animals through wastelage or modifications thereof. The wastelage plan provides two primary advantages: (a) sanitary disposal of organic waste and (b) improved efficiency in feed used for livestock production. ."

"Organic waste from ruminants has a chemical constitution similar to the feed ingested and, in addition, is enriched by the presence of an abundance of rumen microbial matter. Organic waste as it is voided by ruminants is a fermentation product biologically safe for animals and it has none of the characteristics of organic waste products generally classified under the heading 'filth'."

A testing and development period of several years at Auburn University is described. The excess of manure not recycled to steers may be fed to ewes and beef cows. If they are on pasture, they provide land spreading services. If not, a process of yeast production, still under investigation, may provide the answer to complete disposal.

1969-1004
APPELL, H. R.; WENDER, I.; and MILLER, R. D.
Solubilisation of Low Rank Coal with Carbon Monoxide and Water
Chemistry and Industry 1969: 1703

At 4500 psi and 380-400°C, lignite underwent a 90-95 percent conversion. Bituminous coal at the same pressure and 375-425°C underwent less than 75 percent conversion. Conversion increases sharply with pressure to about 1000 psi, and increases gradually thereafter. Conversion increases with water content to a 1:1 ratio. The process is rapid.

1969-1005
BANDEL, Linda Sue and ANTHONY, W. Brady
Wastelage -- Digestibility and Feeding Value (Abst)
Jnl. Animal Sci. 28: 152
Abst: McQ & B B-218

A ratio of wastelage to whole corn of 2:3 is nearly optimum for slaughter cattle.

1969-1006
BELL, R. G.
Biological Treatment of Poultry Manure Collected from Caged Laying Hens
Compost Sci. 10(3): 18-21

Manure was collected from tanks of water and from dry floors beneath hen cages. The liquid manure was subjected to primary treatment which separated it into supernatant, fine sediment and coarse sediment. Even after 13 days forced aeration, the liquid portion was unacceptable for discharge to water courses. The fine sediment concentrated the odor. After 30 days in an anaerobic digester, it was unacceptable for surface spreading. The coarse sediment, after 14 days incubation at 55°C, was good compost. Moral: The manure should not be diluted.

Manure as produced is too moist, too rich in nitrogen, and too fine-grained for composting. By adding ground corn cobs, one half pound of cobs per pound of manure, a mixture resulted which behaved well on two scales of laboratory testing. A field test is under way.

1969-1007
BERNARD, Harold
Effects of Water Quality Standards on the Requirements for Treatment of Animal Wastes
Cornell Univ. Conf. on Agric. Waste Mgmt. p. 9-16
Abst: McQ & B C-096; W71-02704

Costs are computed for the treatment required to permit direct runoff of feedlot effluent to receiving waters. They are such that control, or preferably elimination, of runoff is far more economical.

1969-1008
BHAGAT, Surinder K. and PROCTOR, Donald E.
Treatment of Dairy Manure by Lagooning
WPCF Jnl. 41: 785-795
Abst: McQ & B B-075; W70-09335

Lagoons provide a solution to waste disposal problems low in cost of construction, operation, and maintenance. Performance of a chain of three lagoons on the campus of Washington State University is described. With a total area of about one acre the lagoons receive about 20 percent of the manure from a dairy herd of 100-150 head housed on a concrete-paved lot. The balance of the manure is hauled to a storage area. Effluent from the third lagoon, when such occurs, is pumped to hay fields. Its possible use as flushing water is suggested.

1969-1009
BLACK, S. A.
Farm Animal Waste Disposal in Ontario
16th Ontario Industrial Wastes Conf. Niagara Falls 15-18 June
Abst: [Farm Animal Wastes Are a Potential Major Source of Pollution]
Water and Wastes Engrg. 6: Sept. p. 14
Abst: [Farm Animal Waste Disposal in Ontario] Water and Poll. Control
107: Oct. p. 19

Large-scale livestock-producing farms are actually industries and should be so regarded in pollution abatement. Proper management of wastes, with land disposal to conserve the nutrient values, rather than treatment is called for. Odors can be controlled.

1969-1010
BLOODGOOD, Don E. and ROBSON, C. M.
Aerobic Storage of Dairy Cattle Manure
Cornell Univ. Conf. on Agric. Waste Mgmt. p. 76-80
Abst: McQ & B C-103; W71-02711

A series of laboratory tests at Purdue indicates that "aerobic storage of manure from dairy cattle has promise of minimizing the odor problem encountered in the spreading of unaerated material after storage."

1969-1011
BOYD, Claude E.
The Nutritive Value of Three Species of Water Weeds
Econ. Botany 23: 123-127

Tests on water hyacinth, water lettuce, and hydrilla indicated that they have mean crude protein levels as high as those of many high quality forages. Before being of use as a feed they require dehydration. Composition changes as the plants age.

1969-1012
BRESSLER, G. O.
Solving the Poultry Manure Problem Economically Through Dehydration (Abst)
Poultry Sci. 48: 1789-1790
Abst: McQ & B B-276

Penn State University has perfected a two-stage drying process for which the cost of electricity and fuel is less than $4 per ton. The first stage, stirring in the poultry house, reduces the moisture from an original 75 percent to 30 percent. The second stage, drying in a commercial dryer at 300 lb/hr, reduces the moisture to nine percent. The final weight is one-third the original.

1969-1013
BRISCOE, E. R. E.
Treatment of Agricultural Wastes
Effluent and Water Trtmt. Jnl. 9: 439, 441-443, 445, 446

Land spreading involves smell and the possible presence of toxic and/or pathogenic matter. It is unpleasant labor, subject to severe climatic limitations and to mechanical breakdown.

Various extended aeration systems -- oxidation ditches, oxidation tanks, lagoons in series, and lagoons with effluent being treated in oxidation ditches -- operating in the Netherlands, the UK and the U. S. are described. Costs are considered to be reasonable and a good quality effluent can be produced.

For poultry manure, drying is recommended. "The end product could be worth £6 to £11 per ton." Smell is a major problem. While scrubbing can prevent smell, it may not be economical.

1969-1014
BRUGMAN, H. H.; DICKEY, H. C.; and GOATER, J. C.
Poultry Litter, Barley, Sawdust, Urea in Sheep Rations (Abst)
Jnl. Animal Sci. 29: 153
Abst: McQ & B B-221

In a feeding test in Maine in which six different sheep rations each had a crude protein content of 17 percent ±, costs ranged from 4.5 ¢ to 7.1 ¢ per kg. There was no significant difference in feed efficiency.

1969-1015
BURNETT, William E. and DONDERO, Norman C.
Microbiological and Chemical Changes in Poultry Manure Associated
with Decomposition and Odor Generation
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 271-291
Abst: McQ & B C-126; W71-02734

Abst. by authors: "Changes in the microbial and chemical compositions of batch lots of 'dry' and 'liquid' poultry manure during decomposition were related to the production of offensive odors. The decomposition of uric acid by both aerobic and anaerobic uricolytic bacteria appeared to be related to the formation of significant quantities of ammonia. The number of sulfate-reducing bacteria, including *Desulfovibrio* species, increased during the course of decomposition of liquid poultry manure. These organisms were implicated as producers of some of the hydrogen sulfide in liquid poultry waste. There were apparent correlations between an increase in odor intensity of liquid manure with increased storage time and the concentrations of volatile organic acids, ammonia, and sulfides."

The paper contains a comprehensive literature review with 53 references.

1969-1016
CABES, Leon J., Jr.; COLMER, Arthur R.; BARR, Harold T.; and TOWER
Benjamin A.
The Bacterial Population of an Indoor Poultry Lagoon
Poultry Sci. 48: 54-63
Abst: McQ & B B-272; W71-04921

Results of a series of investigations at Louisiana State University are discussed, tabulated, and compared with values reported in the literature. ". . . whatever the shortcomings of the present lagoon scheme for the stabilization of poultry manure may be, it is a strong step in the right direction."

1969-1017
CALVERT, C. C.; MARTIN, R. D.; and MORGAN, N. O.
House Fly Pupae as Food for Poultry
Jnl. Econ. Entom. 62: 938-939

The laboratory preparation of dried fly pupae is described and the chemical analysis is tabulated. The dried pupae contained 63.1 percent protein and 15.5 percent fat, both of good quality. Preliminary tests are encouraging.

1969-1018
CALVERT, C. C.; MARTIN, R. D.; and MORGAN, N. O.

Dual Roles for House Flies in Poultry Manure Disposal (Abst)
Poultry Sci. 48: 1793
Abst: McQ & B B-277

"A study was conducted to determine the maximum number of house fly pupae that will develop in poultry manure, the effect of this development on the physical properties of the manure, and the nutritive value of the fly pupae.

"Fresh hen feces will support the growth of 3 pupae per gram at a temperature of 23° to 26°C. At this temperature the feces lose about 20% more moisture than feces without pupae. Feces with pupae are essentially odorless, loose, and crumbly in texture and have a moisture content of about 46%.

"An experiment was conducted with dried, ground pupae (63.1% protein) diluted with cellulose to contain 50% protein, to determine if this material would support chick growth. This protein source was equal to soybean meal (50% protein) in supporting growth in the chick through the first two weeks of life."

1969-1019
CASLER, George L.
Economic Evaluation of Liquid Manure Systems for Free Stall Dairy Barns
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 401-406
Abst: McQ & B C-138; W71-02746

The economic factors influencing decisions to adopt liquid manure handling for free-stall dairy barns in the northeastern U. S. are 1) the reduction in labor requirement, 2) the elimination of a disagreeable daily chore, 3) the modification of labor distribution, 4) the combination of waste treatment of manure and milking parlor waste, 5) the increased value of the manure, and 6) the reduction in total costs. Each item is discussed in some detail and typical cost values are cited.

1969-1020
CIORDIA, H. and ANTHONY, W. B.
Viability of Parasitic Nematodes in Wastelage (Abst)
Jnl. Animal Sci. 28: 133-134
Abst: McQ & B B-217

Even with nematode eggs present in the feces, no larvae were found in any sample of wastelage examined.

1969-1021
CLAYTON, J. T. and FENG, T. H.
Aerobic Digestion of Diluted Animal Manure in Closed Systems -- Temporary Expedient or Long Range Solution?
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 81-87
Abst: McQ & B C-104; W71-02712

A simple anaerobic-aerobic system designed to recirculate flushing water and to operate at least six months between cleanouts was designed, built, and tested at the University of Massachusetts. Performance characteristics are reported. Unanswered questions remain.

1969-1022
COOPER, G. S.; KETCHESON, J. W.; and WEBBER, L. R.
Agriculture as a Contributor to Pollution
AIC Review 24(3): 9-15
Abst: McQ & B B-677

"Increasingly, atmospheric pollution is being traced to liquid manure handling systems." To reduce this, mechanical aeration, even in amounts well below those found necessary for stabilization of the waste, has been found effective. Air pollution from liquid manure under confined conditions has resulted in suffocation of humans and animals.

Water pollution from runoff is mentioned.

Means of utilizing nitrogen under Canadian conditions are discussed in some detail. Corn, potatoes, hay, and pasture have proved to be effective in Ontario. In Western Canada, grains, especially where significant quantities of straw are left at harvest, should not receive heavy applications of manure.

1969-1023
DALE, A. C.; OGILVIE, J. R.; CHANG, A. C.; DOUGLASS, M. P.; and LINDLEY, J. A.
Disposal of Dairy Cattle Wastes by Aerated Lagoons and Irrigation
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 150-159
Abst: McQ & B C-112; W71-02720

A field trial of 88 days duration is described for a lagoon 50 ft by 70 ft in area and 5.5 to 7 ft deep. An aerator (2 hp first 44 days, 5 hp last 44) was floated in the center of the pond and held by guy wires. Adjacent cropland (grassland) was irrigated by spray irrigation with a 2 to 3 percent maximum solids content with a half-inch application every fourth day.

The authors conclude that the system is odorless, that it provides a place to dispose of wastes at all times, that nutrients are saved and returned to the land, that runoff into streams and ditches is minimized, that pollutional characteristics of all wastes are greatly lowered, that costs are not excessive, and that little labor is required.

1969-1024
EBY, Harry J. and WILLSON, G. B.
Poultry House Dust, Odor, and Their Mechanical Removal
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 303-309
Abst: McQ & B C-128; W71-02736

Removal of dust, and with it considerable odor, is mechanically feasible by means of filters. Filter cleaning, however, is impractical and one-time use is too expensive.

1969-1025
EDWARDS, J. B. and ROBINSON, J. B.
Changes in Composition of Continuously Aerated Poultry Manure with Special Reference to Nitrogen
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 178-184
Abst: McQ & B C-115; W71-02723

Aeration of stored waste up to the time of land spreading appears to be the most promising method of odor control for liquid manure. To study the nitrogen transformations in continuously aerated liquid manure and to determine the most efficient means of eliminating nitrogen where disposal on insufficient land is contemplated, or of conserving nitrogen where crop utilization is feasible, the authors conducted laboratory, oxidation ditch, and analytical studies reported in this paper.

1969-1026
EL-SABBAN, F. F.; LONG, T. A.; GENTRY, R. F.; and FREAR, D. E. H.
The Influence of Various Factors on Poultry Litter Composition
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 340-346
Abst: McQ & B C-132; W71-02740

"A study was conducted to determine the chemical composition of poultry waste (litter and manure), relevant to its possible utilization as a source of nutrients." Wide variations, related to a number of factors, were found. Results are tabulated and discussed.

1969-1027
FLEGAL, C. J. and ZINDEL, H. C.
The Utilization of Dehydrated Poultry Waste by Laying Hens (Abst)

Poultry Sci. 48: 1807
Abst: McQ & B B-278

Four groups of chickens were fed rations containing 10 percent, 20 percent, and 40 percent DPW and 40 percent DPW plus 4.5 percent added animal fat. The 10 percent ration produced the most eggs in the 366-day period and the 40 percent-with-added-animal-fat ration produced the least. There were, however, no statistical differences in number, weight, or shell thickness for the four groups.

1969-1028
FOREE, Gerald R. and O'DELL, Richard A.
Farm Waste Disposal Field Studies Utilizing a Modified Pasveer Oxidation Ditch, Settling Tank, Lagoon System
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 185-192
Abst: McQ & B C-116; W71-02724

Measurements are described and results tabulated and plotted for a highly satisfactory facility handling the wastes from ten sows and their litters.

1969-1029
GILLHAM, R. W. and WEBBER, L. R.
Nitrogen Contamination of Groundwater by Barnyard Leachates
WPCF Jnl. 41: 1752-1762
Abst: McQ & B B-079; W70-00665

Nitrogen pollution below feedlots is cited in literature references. The paper reports on an investigation in Ontario under a barnyard housing about 65 head of cattle every winter. Manure had accumulated for over 50 years. The water table is 8 ft below the surface and bedrock is 16 ft below surface.

Concentrations of nitrate varied, with the effects of dilution and flushing being evident.

1969-1030
GRIEL, L. C., Jr.; KRADEL, D. C., and WICKERSHAM, E. W.
Abortion in Cattle Associated with the Feeding of Poultry Litter
Cornell Vet. 59: 226-235
Abst: McQ & B B-488

A large number of abortions which occurred in a herd of cattle that had grazed on pasture heavily fertilized with dried poultry litter was attributed to estrogens present in the chicken feed.

1969-1031
GRUB, W.; ALBIN, Robert C.; WELLS, Dan M.; and WHEATON, R. Z.
Engineering Analyses of Cattle Feedlots to Reduce Water Pollution
ASAE Trans. 12: 490-492, 495 [ASAE Paper 68-929]
Abst: McQ & B B-036, G-044; W71-02685

The composition and quantity of wastes on a cattle feedlot are functions of ration fed, of moisture content, and of animal size. "Accumulated feedlot wastes may undergo practically no change in the feedlot other than dehydration, or they may be almost completely stabilized by composting action on the feedlot floor." Sprinkling to promote composting would "undoubtedly result in increased problems from fly infestation and odor production."

Quantity and quality of runoff is affected by amount and intensity of precipitation, surfacing material of the feedlot, land slope, depth and moisture content of waste accumulation, topographic layout of the feedlot, and composition of the ration. Studies on a feedlot at Lubbock, Texas, are reported and analyzed.

1969-1032
GRUB, W.; ALBIN, Robert C.; WELLS, Dan M.; and WHEATON, R. Z.
The Effect of Feed, Design, and Management on the Control of Pollution from Beef Cattle Feedlots
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 217-224
Abst: McQ & B C-119; W71-02727

The composition and quantity of wastes on beef cattle feedlots vary considerably with animal size, climatic variation, and ration fed. Cattle wastes, when moist, are readily degraded by microorganisms and are relished by many insects, particularly flies.

The amount and quality of runoff is affected by the amount and intensity of precipitation and by the antecedent moisture content. Dry manure is subject to prompt runoff with erosion; moist manure tends to hold further moisture. More and stronger runoff occurs from paved than unpaved lots. Land slope and depth of manure accumulation obviously affect runoff. While deep layers tend to stabilize, the amount of fresh manure remains relatively constant. Dehydrated manure, when wetted, regains its original potency. The feedlot layout and ration fed also affect runoff.

1969-1033
HARMON, B. G.; JENSEN, A. H.; and BAKER, D. H.
Nutritive Value of Oxidation-Ditch Residue (Abst)
Jnl. Animal Sci. 29: 136
Abst: McQ & B B-220

Swine excreta suspended in water (ODR) was substituted for portions of corn-soymeal ration for weanling rats. "The digestible energy decreased linearly as ODR was added to the diet."

1969-1034
HAZEN, T. E. and LIPPER, R. I.
Workshop Session (in Animal Wastes as Water Pollutants)
WPC Rsch. Series, DAST-26, 13040 EYX, Chap. 21, p. 298-300

Intensive research is necessary to determine the appropriate limitations on nitrogen in water supplies and the possibly detrimental effects of high rates of application of wastes to land.

1969-1035
HINES, N. William
Legal Aspects
WPC Rsch. Series, DAST-26, 13040 EYX, Chap. 26, p. 365-376

Little legal attention has been directed to non-point sources of pollution as yet. Feedlots, agriculture's major point source, are being regulated by states with increasing thoroughness.

1969-1036
JOHNSON, Thomas H. and MOUNTNEY, G. J.
Poultry Manure Production, Utilization and Disposal
World's Poultry Sci. Jnl. 25: 202-217
Abst: McO & B B-316

The paper presents a review of the literature with 61 references listed. The disposal and utilization methods discussed are:
fertilizer (supply far exceeds demand);
incineration (self-sustaining if moisture content low enough; the ashes have some value for phosphorus and potassium);
dehydration (rather costly; dust and odor);
feed supplements (FDA disapproves);
gas production (high rate necessary for economic feasibility);
composting (mix with drying agent);
lagoons (conflicting recommendations);
disposal as sewage (physically possible, financially prohibitive);
spraying (slurry simplified handling); and
furrow cover (effective).

1969-1037
JOHNSON, Thomas H. and MOUNTNEY, G. J.
Bibliography of Production, Utilization and Disposal of Poultry Manure
Ohio Agr. Rsch. and Dvpt. Center, Dept. of Poult, Sci., Dept. Series 74, 51 p.

The bibliography cites 596 articles which have appeared in U. S. and foreign publications. The arrangement is alphabetically by author. While many of the articles cited are abstracted in this volume, there are a large number which are not.

1969-1038
JONES, Don D.; DAY, Donald L.; and CONVERSE, James C.
Field Tests of Oxidation Ditches in Confinement Swine Buildings
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 160-171
Abst: McQ & B C-113; W71-02721

Design criteria for oxidation ditches have been under study at the University of Illinois since 1966. Problems encountered are foaming (particularly shortly after startup), ammonia odors, and poor treatment. These may be minimized by maintaining an adequate velocity in the ditch by submerging the rotor to about one-third the liquid depth and using a detention time of 50 days. The effluent is not fit for discharge to surface water.

1969-1039
JONES, P. H.
Theory and Future Outlook of Animal Waste Treatment in Canada and the United States
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 23-36
Abst: McQ & B C-098; W71-02706

Anaerobic treatment involves more or less odor. The socially acceptable, but more difficult and expensive, procedures are aerobic. Potential solutions discussed are:

1) integrated farming with land spreading;

2) anaerobic holding systems and anaerobic lagoons;

3) aerobic systems:

    a. oxidation ponds,

    b. aerated lagoons,

    c. oxidation ditches,

    d. air aspirators, and

    e. activated sludge and bio-filters;

4) complete treatment (seldom economic);

5) aerobic digestion with methane gas production;

6) drying and/or incineration (air pollution); and

7) aerobic composting after mixing with dry refuse.

The future includes greater urban sprawl and more rural non-farm residences. It may include "man made" land renovated by sludge disposition and contracted manure handling services.

Twenty-seven references are listed.

1969-1040
KEEN, Montague
Urgent Dilemma of Farm Effluents
Munic. Jnl. 77: 722, 724

Discharges of animal wastes to sewers had been rather common in the UK until an Act of Parliament in 1961 permitted the receiving authority to assess charges and to refuse loads which caused treatment plant capacities to be exceeded. Land disposal is often not feasible and discharge to streams is forbidden. "The Government has casually legislated in 1961 in a fashion which would not merely control but prohibit the discharge of many farm wastes, but without having any clear idea of what farmers were expected to do to survive." Resulting political jockeying by the National Farmers' Union is described.

1969-1041
KOLEGA, John J.; NELSON, Gordon L.; and CRAVES, Quintin B.
Analyses for Oxygen Transfer Coefficients in Rotor Aeration Systems
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 63-75
Abst: McQ & B C-102; W71-02710

From theoretical considerations, dimensional analysis, and laboratory testing, the authors derive an equation for the rate of oxygen transfer per revolution, OTC/N, as a function of the Reynolds number, the Froude number, the ratio of paddle immersion to rotor diameter, and the ratio of liquid depth to rotor diameter. It is

$$\frac{OTC}{N} = (7.42 \times 10^{-7}) \left[Re^{0.70} \times Fr^{-0.19} \times \frac{Pi}{D}^{0.86} \times \frac{Pw}{D}^{0.18} \times \frac{d_1}{D}^{-0.28} \right]$$

1969-1042
LASALLE, Robert M., Jr. and LAUNDER, Mark
Manure Conservation
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 245-248
Abst: McQ & B C-122; W71-02730

The authors, president and consulting engineer respectively for Hupsi Corporation, describe a process of salvaging poultry manure for fertilizer and feed on which the corporation has a patent pending.

"We propose that troughs of suitable material be placed under the chickens and that a flow of weak phosphoric acid solution be maintained in these troughs. Droppings will be immediately stabilized, denatured and deodorized upon falling into this solution."

"We intend to do further study of the possibility of extracting proteins, carbohydrates and any other material of animal food value from the phosphoric acid solution before preparing as fertilizer. . . These materials are preserved in the acid state much as sauerkraut or ensilage."

"By refrigerating the solution flowing under the chickens, the chicken house is completely and perfectly air-conditioned."

Gross profit is estimated to be $14.50 per ton of dried manure.

1969-1043
LAW, James P.
Nutrient Removal from Enriched Waste Effluent by the Hydroponic Culture of Cool Season Grasses
USDI FWQA WPC Rsch. Series 16080-10/69 33 p.

In tests with tall fescue and perennial ryegrass grown in hydroponic culture tanks supplied with secondary sewage effluent the percentage removals of nitrogen, phosphorus, and potassium were four to eight percent, two to five percent, and six to twenty-two percent, respectively. Much further research will be required if the method is to approach feasibility.

1969-1044
LINTON, R. E.
The Economics of Poultry Manure Disposal
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 388-392
Abst: McQ & B C-136; W71-02744

The paper describes an economic analysis of the costs of land disposal of poultry wastes in a resort region of the Catskills where some relatively long hauls are involved. Fertilizer-equivalent values are attributed to the manure with penalties for the diseconomy of spreading at the wrong season of the year for most effective fertilizer use. Alternatives (stated without discussion to be dehydration, incineration, and biological decomposition) remain to be evaluated.

1969-1045
LOEHR, Raymond C.
Animal Wastes -- A National Problem
ASCE Proc. 95: SA 2: 189-221
Abst: McQ & B B-092; W71-05420

This paper, with its 86 references, is an excellent summary of the state of the art as of August 1967. Emphasis in the past has been upon return of wastes to the land. With confinement feeding on small areas, the value of the fertilizer is often substantially less than the cost of collecting, conveying and spreading. Moreover, caution is required to avoid runoff from spread manure and possible infection to man and livestock.

Methods of handling and disposal discussed include:

a) anaerobic digestion (affected by temperature; the effluent requires further treatment);

b) aerobic treatment (extremely large surface areas and volumes involved if this is the sole treatment used);

c) anaerobic lagoons (effective, but should not extend to the area under slotted floors of confinement sheds);

d) anaerobic-aerobic systems (often satisfactory if ultimate discharge does not reach streams);

e) land disposal (to avoid runoff, incorporate soon after spreading; confinement feeding has altered the feasibility of this method);

f) incineration and drying (reduce total volume and minimize pollution potential); and

g) miscellaneous processes ("Because of technical or economic difficulties, these processes have not found wide application").

The latter include composting (for which a market is required), vacuum filtration, lime and chlorine treatments (for odor control primarily), conventional sewage treatment processes (for dilute wastes only), and feeding of dried manure as a portion of the ration to the same or other animals. "At present, there appears to be no profitable method of livestock manure utilization and it is unlikely that one will be developed." Research needs are indicated.

1969-1046
LOEHR, Raymond C.
The Challenge of Animal Waste Management
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 17-22
Abst: McQ & B C-097; W71-02705

Land disposal of animal wastes has become "doubtful from a profit standpoint." Operators with too little land are faced with social and legal restrictions on disposal of low-value waste. Better location planning of facilities will be required to minimize runoff and odor.

Waste management must be integrated to minimize overall animal management. "The problems we are discussing today have arisen because of rapid progress in efficiency of animal production without enough anticipation or understanding of the difficulties that would occur with waste treatment and disposal."

Cost analyses are needed. Research areas are listed.

1969-1047
LOEHR, Raymond C.
Treatment of Wastes from Beef Cattle Feedlots -- Field Results
Cornell Univ. Conf. on Agric. Waste Mgmt. p. 225-241
Abst: McQ & B C-120; W71-02728

This paper reports the behavior of a field demonstration complex of an anaerobic lagoon followed by an aerobic lagoon and a polishing (also aerobic) lagoon for the treatment of beef cattle feedlot wastes and runoff. The ability of such a battery of lagoons was demonstrated. For most effective use of such a system, it would be preferable to handle solids semi-dry rather than treat them, the characteristics of the lagoons should be understood by the operators, feed should be as continuous as feasible, and at least half the solids in the anaerobic lagoon should be left as "seed" at any cleaning. The final effluent is not acceptable in a watercourse.

1969-1048
LONG, T. A.; BRATZLER, J. W.; and FREAR, D. E. H.
The Value of Hydrolyzed and Dried Poultry Waste as a Feed for Ruminant Animals
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 98-104
Abst: McQ & B C-106; W71-02714

Nitrogen was supplied as soybean oil meal, as hydrolyzed poultry waste (pressure cooked with 30 lbs of steam, 30 min), and as cooked poultry waste (30 min at atmospheric pressure) in isonitrogenous, equicalorie rations to lambs. After processing, the poultry waste was dried and large particles were removed. Palatability was low. Performance was comparable on all diets.

When fed to beef, hydrolyzed poultry wastes gave the best tasting beef, and dried poultry wastes the poorest in a four-ration comparison. Results are tabulated.

1969-1049
LOWMAN, B.
The Apparent Digestibility of Energy and Protein in Toplan Dried Poultry Manure (Abst)
Animal Production 11: 276

Apparent digestibilities of Toplan (dried poultry manure) as determined by direct measurements in sheep feeding and by extrapolation from other diets were, respectively: for dry matter 56.6 percent and 56.6 percent, for organic matter 66.6 percent and 67 percent, for energy 60.3 percent and 60.9 percent, for nitrogen 77.1 percent and 78.7 percent, and for copper 24.2 percent and 13.5 percent. "Toplan" is a British trade name.

1969-1050
McCALLA, T. M.; FREDERICK, L. R.; and PALMER, G. L.
Manure Decomposition and Fate of Breakdown Products in Soil
WPC Rsch. Series, DAST-26, 13040 EYX, Chap. 17. p. 241-255

The value of the nutrients in manure is slightly greater than $1 per ton. Some constituents, such as ammonia, are toxic in excessive applications. The value of manure as a soil conditioner has probably been overrated.

Manure will decompose in a feedlot with significant losses in nitrogen, volatile solids, and carbon. Under heavy applications and/or in wet soil, manure may become anaerobic. Denitrification then occurs and the manure releases products detrimental to plant growth.

1969-1051
McEACHRON, L. W.; ZWERMAN, P. J.; KEARL, C. D.; and MUSGRAVE, R. B.
Economic Return from Various Land Disposal Systems for Dairy Cattle Manure
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 393-400
Abst: McQ & B C-137; W71-02745

Tabulations present the costs of hauling and handling dairy manure under conditions found in the northeastern U. S., yields of various crops under various manure application schedules, and calculated dollar return for the manuring. "Without a charge for hauling and spreading dairy cattle manure crop yield returns ranged from $1.42 per ton to a deficit of $.26."

1969-1052
McKINNEY, Ross E.
Manure Transformations and Fate of Decomposition Products in Water
WPC Rsch. Series, DAST-26, 13040 EYX, Chap. 18. p. 256-264

Manure in water leads to complex biochemical activity. In all circumstances, the end result is not a purified product, but is one which may be spread for final land disposal without obnoxious odors. Treatment systems evaluated include oxidation ponds, aerated lagoons, oxidation ditches, and anaerobic lagoons.

1969-1053
MEEK, A. M.; MERRILL, W. G.; and PIERCE, R. A.
Problems and Practices in Some Systems of Manure Handling in Northern Europe
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 254-259
Abst: McQ & B C-124; W71-02732

Installations described include dairy barns in Scotland with slatted floors, drainage to a sump, and pumping to a honey wagon. In England, a barn with removable metal slats permitted manure removal by means of a front-end loader. A three-day odor problem accompanies cleaning. Norwegians tend to use pit storage under the barn. Danes prefer continuous flow to outside storage. Noxious gases are a concern in Scandinavia, but little firm data seems to be available on them.

1969-1054
MELLER, Floyd H.
Conversion of Organic Solid Wastes into Yeast
USPHS Pbln. No. 1909. 173 p.

While this publication limits itself to conversion studies of municipal wastes, waste paper, and bagasse, some of the findings have wider application. It is concluded that the hydrolysis-fermentation approach has promise, though the calculated costs of producing Torula yeast from hydrolyzed solid wastes place this source of protein "at best at the high end of the current high protein supplement price range."

In an appendix the "City Farm Concept" is sketched. It is contemplated that animals would convert municipal wastes to meat with the manure joining the sludge of the municipal plant for disposal.

1969-1055
MIDWEST PLAN SERVICE
Anaerobic Manure Lagoons
Agr. Engrs. Digest AED-1. 2 p. [Revision of 1963 publication]

Mechanics of functioning, formulae for sizing, location of inlets and outlets, and principles of management are discussed. All overflow from an anaerobic lagoon should be captured and led to an aerobic lagoon. Lagoons should be loaded frequently, with bedding being excluded. Sludge should be removed when it begins to interfere with good operation and be applied to the land.

1969-1056
MILLER, B. F.
Biological Digestion of Manure by Diptera
Feedstuffs 41: 20 Dec. p. 32-33

A breeder stock of house flies may be developed from a disease-free stock. Fly eggs, deposited on manure available in the fly cages, may be picked up daily and transferred to fresh manure. After hatching, the larvae feed on the manure reducing its moisture content by 60 percent and stabilizing it. After pupation, two or three days are available as harvest time. The pupae provide an excellent source of protein for chicks.

"Possibly the most practical method of harvesting may be to permit the flies to emerge as adults under controlled conditions. They could then be killed by heat and utilized as a feedstuff."

1969-1057
MILLER, B. F.; LINDSAY, W. L.; and PARSO, A. A.
Use of Poultry Manure for Correction of Zn and Fe Deficiencies in Plants
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 120-123
Abst: McQ & B C-109; W71-02717

Deficiencies in zinc and iron are common in Colorado, especially where top soil has been removed in leveling land for irrigation. Tests reported indicate that fresh poultry manure is effective in supplying these deficiencies, whereas the ashed residues are of little help.

1969-1058
MILLER, B. F. and SHAW, J. H.
Digestion of Poultry Manure by Diptera (Abst)
Poultry Sci. 48: 1844-1845
Abst: McQ & B B-281

Diptera which can develop from egg to pupa in five to six days at 37°C can effectively stabilize poultry manure. The larvae may be harvested by spreading the manure thinly on a screen under an intense light source. In avoiding the light, the larvae will crawl through the screen. Pupae can be separated from manure by flotation.

In tests larvae removed 80 percent of the organic matter and reduced the moisture from 75 percent to 50 percent. About 25 to 30 g of larvae were produced from each kg of fresh poultry manure.

1969-1059
MINER, J. Ronald

Agricultural (Livestock) Wastes [In a Review of the Literature of
1968 on Wastewater and Water Pollution Control]
WPCF Jnl. 41: 1169-1178
Abst: McQ & B B-076

A short summary of the contents of 72 references, approximately a paragraph devoted to each, is given. Nine additional references are listed. Subheadings used in the classification of the articles are Manure Handling Systems, Manure Gases and Odors, Waste Characterization, Cattle Feedlot Wastes, Application of Waste to Cropland, and Wastes Treatment Studies.

1969-1060
MINER, J. Ronald and WILLRICH, T. L.
Livestock Operations and Field-Spread Manure as Sources of Pollutants
WPC Rsch. Series DAST-26, 13040 EYX, Chap. 16, p. 231-240

Potential pollution sources discussed include runoff from range and pasture, from cropland following manure application, and from feedlots and similar unroofed enclosures. The first is usually negligible, the second tends to be critical only when spreading occurs on frozen ground or snow-covered surfaces, and the third required control because of high-strength wastes with a slug effect due to their entering streams only as storm runoff. Diversion channels, settling basins, and detention ponds are useful as means of control. Evaporation or irrigation may be effective for disposal of liquids.

Ground water may be polluted by percolation from feedlots, disposal areas, or field-spread manure. The capacity of the soil for absorbing and transforming nutrients should not be exceeded.

1969-1061
MOORE, James A.
Animal Waste Management to Minimize Pollution
WPC Rsch. Series, DAST-26, 13040 EYX, Chap. 20. p. 286-297

Management of manure consists of four steps: collection, storage, treatment, and utilization or disposal. Collection may be by wet methods, which have the advantage of easy mechanical handling by pumps, or by dry, which have the advantage of minimizing the volume to be handled. Storage is used to preserve nutrient value and minimize pollution until further handling is convenient or appropriate. Treatment may be by dry systems (drying, dehydration, incineration, or composting) or by wet systems. These latter may involve primary treatment (screening and sedimentation), secondary treatment (anaerobic, aerobic, or both), and in the future may be extended to tertiary treatment (nutrient removal). Utilization and disposal is primarily to the land. A list of 35 references is included.

1969-1062
MOORE, J. A.; LARSON, R. E.; and ALLRED, E. R.
Study of the Use of the Oxidation Ditch to Stabilize Beef Animal Manures in Cold Climates
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 172-177
Abst: McO & B C-114; W71-02722

Tests of an oxidation ditch in Minnesota indicate that it "appears to be a system which can meet the following objectives: (a) control and reduce the large volumes of wastes, (b) reduce the pollutional burden of these wastes and (c) maintain an acceptable nuisance level." Digestion is minimal at low temperatures and foaming is often severe. Oxidation ditch effluent should not be released to public waters.

1969-1063
MORRISON, Joseph L. and PETERSON, O. H.
The Distribution of Arsenic from Reused Poultry Litter in Broiler Chickens, Soil, and Crops
Poultry Sci. 48: 1848

"Although measurable amounts of arsenic (15-30 p.p.m.) were found in the litter, this had no effect on the arsenic content of birds raised on this litter. Similarly, the arsenic content of soil and crops was unaffected by the use of poultry litter as fertilizer."

1969-1064
MUEHLING, Arthur J.
Swine Housing and Waste Management
Univ. of Ill. A. Eng. 873. 91 p.
Abst: McQ & B E-116; W71-00924

Part II: Swine Waste-Management Studies (p. 25-91) provides an excellent state-of-the-art survey of current practice keyed to a list of 155 references. Topics covered are:

Returning Swine Wastes to the Land (p. 31-36)
    Spreading as a solid (often objectionable)
    Spreading as a liquid -- honey wagon, spray irrigation, plow-furrow-cover
    Value of hog wastes for fertilizer

Treatment of Swine Wastes (p. 37-62)
    Anaerobic -- lagoons, digesters
    Aerobic -- naturally aerobic lagoons, mechanically aerobic lagoons, oxidation ditches

Other Methods of Waste Disposal (p. 63-64)
    Dehydration -- "little value. . .difficult and expensive"

Incineration -- "does not seem applicable"
Composting -- "could be used for wet solids. . .by addition of. . . straw"
Use of swine waste in feed -- nutritional value of oxidation ditch sludge appears promising. Pigs fed ration of 15 percent pig feces outperformed those fed 0 percent or 30 percent.

Gases and Odors from Stored Swine Wastes (p. 65-78)

Legal Implications of Waste Handling (p. 79-80)

Recommendations for Future Hog Waste Management Research (p. 81-84)

References on Waste Management (p. 85-91).

Fact sheets, based on this study, were prepared as publications A Eng 875-879. They also carry the serial designation 69-4-A through 69-4-F of the National Pork Producers Council.

1969-1065
NORTON, T. E. and HANSEN, R. W.
Cattle Feedlot Water Quality Hydrology
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 203-216
Abst: McQ & B C-118; W71-02726

The paper derives procedures for predicting the quality and quantity of runoff from existing feedlots by use of hydrologic data.

1969-1066
OKEY, Robert W.; RICKLES, Robert N.; and TAYLOR, Robert B.
Relative Economics of Animal Waste Disposal by Selected Wet and Dry Techniques
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 369-387
Abst: McQ & B C-135; W71-02743

Several possible means of handling beef feedlot wastes in a non-polluting manner were investigated and costs were computed per pound of meat produced for lots carrying 500, 1000, 5000, 10,000, and 25,000 head. It was concluded that dry handling, taking advantage of the relatively low volume of manure, would be more economical than wet handling after dilution. Costs ranged from one to ten cents per pourd depending on process chosen and size of lot. Continued research is necessary.

1969-1067
OSTRANDER, Charles E.
Waste Disposal Management
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 242-244
Abst: McQ & B C-121; W71-02729

Land spreading may well be the least-cost method of disposing of poultry manure. To minimize risk of pollution and nuisance the spreading must be properly timed. This requires storage. Solid or liquid handling may be preferable depending upon circumstances. In any case, good housekeeping and concern for neighbors must be paramount.

1969-1068
OWENS, T. R.; WELLS, Dan M.; GRUB, Walter; ALBIN, Robert C.; and
    COLEMAN, Eugene
Some Physical and Economic Aspects of Water Pollution Control for
    Cattle Feedlot Runoff
Water Pollution Control Fedn., Dallas. 20 p. proc.

With assumed costs appropriate to the High Plains of Texas, and using historical precipitation and evaporation records for the area, calculations are made for the cost of handling runoff vs the risk of overflow of the system. Mechanical (pumping to irrigation or playa lakes) and evaporative (with provision of an adequate holding pond) systems are compared. Secondary considerations such as detrimental effect of undiluted effluent on crops and possibility of groundwater pollution are mentioned.

Modified environmental feeding on slotted floors with continuous, rather than batch, manure disposal would have advantages in increased rate of gain, reduced uncertainty, better animal health, reduced labor requirements, elimination of air pollution, and simplified waste treatment or disposal. The disadvantages would include tripling of capital costs, forfeiture of natural climatic advantages where they exist, and increased annual operating costs.

1969-1069
PRATT, G. L.; HARKNESS, R. E.; BUTLER, R. G.; PARSONS, J. L.; and
    BUCHANAN, M. L.
Treatment of Beef-Cattle Waste Water for Possible Reuse
ASAE Trans. 12: 471-473 [ASAE Paper 68-930]
Abst: McQ & B B-035, G-045; W71-00942

Tests conducted at North Dakota State University in which manure was flushed to a settling tank, the effluent from the settling tank was collected and treated in a secondary tank, and the effluent from the secondary tank was pumped to a holding tank and then used as flushing water are described.

Treatments in the secondary tank were 1) further settling only, 2) forced aeration, and 3) coagulation with filter alum. Data are tabulated. While coagulation proved to be the best of the three treatments, some unmeasured influences of temperature may have been present. The flushing water had color and odor under all three treatments.

1969-1070
QUISENBERRY, J. H. and BRADLEY, J. W.
Nutrient Recycling by Laying Hens
Feedstuffs 41: 1 Feb. p. 19
Abst: McQ & B F-100

Laying hens fed a control diet ("the best one, price considered, that we were able to formulate"), and diets containing 10 and 20 percent of natural mixtures of litter and droppings, adjusted to be isocaloric (916 Kcal. of productive energy) and isonitrogenous (16.00 percent protein), were compared in body weight, egg production (number and weight), mortality, etc. With one exception the performances on nutrient recycled diets were superior to those on the control diet. Calculated values of the recycled nutrients ranged from $19.90 to $72.90 per ton.

1969-1071
RADEMACHER, John M.
Alliance for Action
WPC Rsch. Series, DAST-26, 13040 EYX, Chap. 28. p. 390-396

Effective action for reduction of pollution due to animal wastes will involve inventories, research, development, and demonstrations, but regulation cannot await perfection. Zoning for agriculture may provide a partial answer. Location of facilities and proper management of drainage -- including the exclusion of inflow -- are necessary. Wastes may be used to reclaim lands if economics continues to favor artificial fertilizers.

1969-1072
RADEMACHER, John M. and RESNIK, Anthony V.
Feedlot Pollution Control -- A Profile for Action
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 193-202
Abst: McQ & B C-117; W71-02725

The total problem of agriculture's contribution to environmental degradation is sketched and the history of legislative steps to rectify the situation is reviewed. Re-education, research, and regulation are seen as keys to a better future.

1969-1073
REED, Charles H.
Specifications for Equipment for Liquid Manure Disposal by the Plow-Furrow-Cover Method
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 114-119
Abst: McQ & B C-108

A plow-furrow-cover method of manure spreading eliminates odors and flies. Fertilizer values may be preserved by spreading fresh manure. Five prototype spreaders have been designed and/or tested at the New Jersey Agricultural Experiment Station. A fully reliable, effective, economical spreader is not yet on the market.

1969-1074
SCHELTINGA, H. M. J.
Farm Wastes
Water Pollut. Control 68: 403-409 Disc: 409-413
Abst: McQ & B A-299; W70-06056

Reporting primarily on practice in Holland, the author emphasized the necessity of avoiding discharge of farm wastes to rivers because of the high BOD present. "The usual way to dispose of farm wastes has been and still is to use them as an organic fertilizer on farm land." Lack of balance between production and demand for fertilizer has led to experimentation with oxidation ditches. Construction is described and cost data given.

1969-1075
SCHMID, Lawrence A. and LIPPER, Ralph I.
Swine Wastes, Characterization and Anaerobic Digestion
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 50-57
Abst: McQ & B C-100; W71-02708

The optimum conditions for anaerobic treatment of hog wastes have been shown to require expensive facilities and close supervision. Where partial treatment will suffice, as in the liquification of the wastes to permit reuse as flushing water and to ease handling prior to ultimate land disposal, anaerobic treatment may be effective at moderate cost.

1969-1076
SELTZER, William; MOUM, Stanley G.; and GOLDHAFT, Tevis M.
A Method for the Treatment of Animal Waste to Control Ammonia and
Other Odors
Poultry Sci. 48: 1912-1918
Abst: McQ & B B-282; W71-00332

"Flake paraformaldehyde as it disintegrates has the unique ability to neutralize ammonia gas produced by animal wastes by a direct chemical reaction. Because flake paraformaldehyde liberates formaldehyde gas slowly, it has an antimicrobial action that destroys a variety of organisms capable of producing noxious gases, thus minimizing odors that accompany decaying animal wastes for a prolonged period. Tests show that because of its action the treated animal wastes retain nitrogen at a much higher rate than untreated wastes."

1969-1077
SHANNON, D. W. F. and BROWN, W. O.
Losses of Energy and Nitrogen on Drying Poultry Excreta
Poultry Sci. 48: 41-43
Abst: W71-04925

Losses of energy and nitrogen for various drying procedures were tested. Results were:

		Energy loss	N loss
Freeze dry		1.3%	4.8%
Vacuum dry at 40°C		12.0	28.0
Forced-air oven at	60°C	5.5	4.6
	100°C	3.2	7.8
	120°C	2.8	10.6

1969-1078
SMITH, L. W.; GOERING, H. K.; and GORDON, C. H.
Influence of Chemical Treatments upon Digestibility of Ruminant Feces
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 88-97
Abst: McQ & B C-105; W71-02713

The composition of ruminant feces and barn wastes is largely dependent upon the ration fed and the bedding system used. "The first part of this paper deals with the effect of several chemical treatments upon feces from cattle fed solely orchard grass or alfalfa hay. The effects were measured as changes in CW [cell wall] digestibility ascertained by *in vitro* fermentation and by changes in the chemical composition of the feces. The second part deals with the effect of sodium peroxide treatment on the *in vivo* digestibility of orchard grass feces from cattle when fed to sheep." Results are tabulated and discussed.

1969-1079
SOBEL, A. T.
Measurement of the Odor Strength of Animal Manures
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 260-270
Abst: McQ & B C-125; W71-02733

"Significant observations" based on laboratory studies were that odor production increases with increasing manure volume, but not linearly; that diluted manure has a higher odor strength than undiluted manure; that mixed manure has a stronger smell than unmixed; that mixing releases odors promptly; and that maximum odor production occurs between two and seven days for batch samples.

1969-1080
SOBEL, A. T.
Removal of Water from Animal Manures
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 347-362
Abst: McQ & B C-133; W71-02741

The advantages of removing water from manure are a) a change in handling characteristics, b) a reduction in weight and volume, and c) a reduction in offensive odor. Water may be removed mechanically, thermally, or by absorption in litter or bedding. Mechanical means are ineffective and/or expensive. Thermal removal by natural evaporation is slow, the rate of water loss from a manure surface being less than that from a free water surface. Time requirements vary widely from sample to sample.

1969-1081
TOWNSHEND, A. R.; REICHERT, K. A.; and NODWELL, J. H.
Status Report on Water Pollution Control Facilities for Farm Animal Wastes in the Province of Ontario
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 131-149
Abst: McQ & B C-111; W71-02719

The findings of a 1968 survey are presented. In Ontario, land spreading is universally practiced but difficulties are anticipated as confinement feeding on small land holdings becomes more general. Storage of up to six months is required to avoid spreading on frozen ground or snow. Treatment for release to water courses would be uneconomical. All lagoons in the province have produced more or less odor.

"This status report estimates the pollution potential of farm animal wastes; outlines the present methods of handling liquid manure from confinement operations; tabulates animal waste characteristics, loadings, and population equivalents; gives field data and experiences on typical water pollution control facilities; and concludes with guidelines on the selection, design, and operation of farm waste systems."

1969-1082
VICKERS, Albert F. and GENETELLI, Emil J.
Design Parameters for the Stabilization of Highly Organic Manure Slurries by Aeration
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 37-49
Abst: McQ & B C-099; W71-02707

A series of experiments with an oxidation tank handling diluted poultry manure indicate that such an installation would be practical for a farmer in that it is reliable, requires a minimum of maintenance and operation, and produces a nuisance-free effluent in that it has no odor and does not attract flies. The effluent is still too potent for stream discharge. Liquid and solids in the slurry are easily separable and may be disposed of by land spreading.

1969-1083
WALKER, J. P. and POS, J.
Caged Layer Performance in Pens with Oxidation Ditches and Liquid Manure Storage Tanks
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 249-253
Abst: McQ & B C-123; W71-02731

Hen performance was slightly better and the odor was less offensive over an oxidation ditch than over a liquid manure tank. Foaming and mechanical failures occurred with the oxidation ditch. Aerators should be installed outside the pen area. Dropping boards should be omitted to avoid shock loading.

1969-1084
WARD, John C. and JEX, E. M.
Characteristics of Aqueous Solutions of Cattle Manure
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 310-326
Abst: McQ & B C-129; W71-02737

Aqueous characteristics investigated were BOD, conductivity, pH, oxidation-reduction potential, coagulation and colloidal properties, dissolved solids, volatile solids, and foaming. The information obtained is applicable to the design of aerated lagoons for the treatment of cattle manure.

1969-1085
WEBBER, L. R. and LANE, T. H.
The Nitrogen Problem in the Land Disposal of Liquid Manure
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 124-130
Abst: McQ & B C-110; W71-02718

Studies at Guelph, Ontario, were undertaken to provide guidelines for determining the optimum application of manure to fertilize crops and the maximum safe application without polluting surface or ground water. Crops vary in their use of nitrogen. Corn, potatoes, hay, and pasture grasses, particularly on coarse-textured soils, use large quantities of nitrogen. Enzymatic denitrification, a biological process accomplished by facultatively anaerobic bacteria, may be employed to dispose of nitrogen provided proper nutrients and temperatures are available for the bacteria.

1969-1086
WELLS, Dan M.; ALBIN, Robert C.; GRUB, Walter.; and WHEATON, R. Z.
Aerobic Decomposition of Solid Wastes from Cattle Feedlots
Cornell Conf. on Agr. Waste Mgmt. p. 58-62
Abst: McQ & B C-101; W71-02709

Aerobic composting is an effective means of handling wastes from beef feedlots in the semi-arid High Plains of Texas. The fresh manure may be placed in piles and turned weekly. Fly larvae deposits may be intense the first week. They cannot survive the temperatures which develop within a pile, and the weekly turning period provides adequate fly control.

Experiments with a 55-gallon drum rotating at 3/4 RPM and stationary except for two revolutions twice per day indicated "that stabilization points at which insects are no longer attracted to the mass, bacteria of putrification can no longer be actively supported, coliform bacteria are no longer detected, and high internal temperatures can no longer be maintained are reached at compost time periods of less than ten days."

1969-1087
WELLS, Dan M.; COLEMAN, Eugene A.; GRUB, Walter; ALBIN, Robert C.; and MEENAGHAN, George F.
Cattle Feedlot Pollution Study: Interim Report Number 1 to Texas Water Quality Board
Texas Tech Water Res. Center Publn. WRC 69-7. xi + 34 p.

Laboratory and field investigations on concrete and dirt feedlots led to the following conclusions and recommendations:

1. Conventional aerobic treatment processes are not economically feasible.

2. Undiluted or untreated runoff from feedlots is not suitable for direct application as irrigation on most field crops.

3. Anaerobic treatment processes would appear to offer the best hope for treatment of feedlot runoff.

4. The potential pollution hazard to groundwater needs thorough investigation.

The findings are applicable to the conditions of the High Plains of West Texas. They may require modifications to fit other climatic conditions.

1969-1088
WELLS, Dan M.; GRUB, Walter; ALBIN, Robert C.; MEENAGHAN, George F.; and
COLEMAN, Eugene
Characteristics of Wastes from High Plains Cattle Feedlots
Texas Section ASCE. Lubbock, Texas. 11 Oct 69 22 p. proc.

Laboratory and field tests of the response of a number of varieties of plants to irrigation with the runoff from concrete or dirt-surfaced beef cattle feedlots are reported and discussed. Runoff from the concrete surfaces was more damaging than that from the dirt lots. It was concluded that "runoff from feedlots operated in a conventional manner does not appear to be suitable for direct application as irrigation on most field crops. It appears that such runoff should be applied in limited amounts only to crops with a high salt tolerance and that it should be diluted with fresh water to the maximum possible extent."

Concern was expressed that groundwater might be polluted under unlined ponds or agricultural land irrigated with feedlot runoff.

1969-1089
ANON [Based on Herbert R. APPELL and Irving WENDER]
Novel Process Could Aid in Waste Disposal
Chem. and Engr. News 47: 17 Nov. p. 43

The U. S. Bureau of Mines Coal Research Center at Pittsburgh has demonstrated on a laboratory basis a process by means of which a ton of garbage could be converted to a barrel of heavy low-sulfur oil, water, carbon residue and ash. Pressures of 1000 psi and steam heating at 380°C for 20 minutes are involved. No cost estimates have been made.

1969-1090
ANON [Based on D. J. B. GOWAN]
Who is Helping the Farmer?
Effluent and Water Trtmt. Jnl. 9: 25-29. Comment p. 142, 309, 429

The Secretary of the National Farmers' Union (NFU) of the UK reports that the NFU has secured reduced charges in some cases for farmers discharging their wastes to municipal sewers. He is bitter over the research orientation of the Water Pollution Research Laboratory, the three main Scottish colleges of agriculture, and similar groups whose work he considered to be "either too 'rarified' in relation to the economics of the problem or [which] bore no relation to the physical limitations of farmers considering the worsening labour position on farms."

Two Ministries and the Water Pollution Research Laboratory refute the accusation in appended statements.

1969-1091
ANON [Based on Charles T. RILEY and Ken JONES]
Farm Wastes
Effluent and Water Trtmt. Jnl. 9: 71-72

In rebuttal to Mr. GOWAN [1969-1090], spokesmen for the Ministry of Agriculture, Fisheries and Food point out the diversity of situations arising in waste disposal and the necessity to foresee results of proposed solutions. "Waste disposal must be regarded as a production cost."

1969-1092
ANON [Based on Bryan PLATT]
British Cite Value of Poultry Manure in Ruminant Feeds
Feedstuffs 41: 9 Aug. p. 43

Problems overcome in preparing dried poultry manure as an acceptable (25-50 percent of ration) feed for ruminants in England were the assuring of a sterile product free of bacteriological contamination or extraneous matter with no trace of burning or charring. Unpleasant smells during the processing were reduced and a market was developed for the feathers which were removed, dried, and cleaned. The product, called "Toplan," sells for $28.80 per ton, thus saving 30 percent on feed costs. The contents are crude protein 26.6 percent, carbohydrates 38.7 percent, ash 15.24 percent, moisture 7.68 percent, and oil, phosphorus and calcium.

1969-1093
ANON [Editorial]
Farm Wastes
Munic. Jnl. 77: 703

With intensive agriculture on small holdings far from adequate waste disposal fields, nuisances are intensifying. Subsidies on imported fertilizer might better "be re-channelled to provide more chemical engineering equipment." Heated sludge digestion and the processing of wastes into more easily handled forms, such as poultry pellets, is called for. Incineration may be required.

1969-1094
ANON [Based on Charles T. RILEY]
Disposal of Farm Waste
Surveyor 133: 22 Mar. p. 40

Disposal of animal wastes as a slurry used for irrigation is a dubious practice in high-precipitation areas. Biannual spreading of dried fertilizer on land by contract labor is considered to be the cheapest acceptable practice under British conditions. Oxidation ditches and high-rate biological filters show promise.

"Mr. RILEY mentioned a new variation of 'recirculation' whereby a bullock had half his protein supplied by poultry waste and appeared to thrive on it." Separation of 'clean' runoff from yards, roofs, etc., from that from pens and milking parlors was recommended.

1970-1001
AHO, William A.
Maxi-Mixing Poultry Manure
Poultry Sci. 49: 1363
Abst: McQ & B B-287

Some 1200 cu ft of poultry manure was placed in a pit 14 ft by 85 ft by 1-foot deep (1190 cu ft) and covered by folding the loose soil back into the basin. The mixture is too soft to support the weight of a person but will support farm machinery within a month. Grasses did better in the mixture than in a control. No toxicity was detected in an 8-wk study.

1970-1002
ALBIN, Robert C.
Feedlot Waste-Management Systems
Proc. 1970 Beef Cattle Conf., Texas Tech. p. 8-17

This is a good brief summary of the state-of-the-art in beef feedlot waste disposal with citation of many original papers. Practice in Southwestern feedlots is generally to stockpile manure, often after preliminary spreading for drying, until it is convenient to transport the manure to the fields and turn it under. Runoff is trapped and either pumped to fields for irrigation or to lagoons for evaporation. When used for irrigation, feedlot runoff is diluted with well water.

1970-1003
ANTHONY, W. Brady
Feeding Value of Cattle Manure for Cattle
Jnl. Animal Sci. 30: 274-277
Abst: McQ & B B-222; W71-00329

Summary by author: "Rations containing wet cattle manure were readily consumed by fattening steers and these rations supported gains essentially equal to comparable cattle fed feeds without manure. Cooking or washing manure before mixing it with concentrate for feeding did not improve its feeding value. Carcass data were similar for manure-fed and other cattle. Wet manure collected daily per yearling steer was about 13.5 kg (3.12 kg dry matter) and about 6.6 kg (1.52 kg dry matter) was consumed daily."

1970-1004
APPELL, Herbert R.; WENDER, Irving; and MILLER, Ronald D.
Conversion of Urban Refuse to Oil
USDI Bur. of Min. Tech. Prog. Rpt. 25. 5 p.

Conversions of cellulosic wastes to oil on a laboratory scale at 380°C and 5000 psig without the addition of water unless the moisture content is below 30 percent, and at 250°C and 1500 psig with additional water having been supplied, are reported and discussed. More than two barrels of low-sulfur oil per ton of dry, ash-free waste resulted. "Work on a larger scale in a continuous unit will be started soon; this will enable us to obtain cost estimates and to more thoroughly evaluate the process."

1970-1005
BARTH, Clyde L.
Why Does It Smell so Bad?
ASAE Paper 70-416. 22 p. [To appear in ASAE Trans.]
Abst: McQ & B G-077

"It is the purpose of this paper to bring attention to procedures that might be employed for specific odor determinations and, even more important, to highlight phenomena important in analysis of odor quality and intensity."

The anatomy of the olfactory mechanism is explained and theories on its functioning are analyzed. Means of conducting odor strength determinations are described. Characteristics of odor quality, of which "there is no commonly accepted standard -- no point of reference -- from which to judge," are tabulated for five proposed systems. The paper includes a list of 65 references.

1970-1006
BELL, R. G.
The Influence of Aeration on the Composting of Poultry Manure -- Ground Corncob Mixtures
Jnl. Agr. Engrg. Rsch. 15: 11-16
Abst: McQ & B B-107; W71-02683

Fresh poultry manure -- with a moisture content near 75 percent, a carbon-to-nitrogen ratio near 10, and a structure consisting of many fine particles -- must be mixed with drier, coarser material with a higher carbon-to-nitrogen ratio to provide good raw material for composting. In the experiments reported, kiln-dried corncobs ground to pass a quarter-inch screen were mixed with the poultry manure in the ratio of two parts manure to one part corncobs. Laboratory studies indicated that optimum aeration rate for the production of a stable sanitary compost was four litres of air per sq m per min for every 10 cm depth of composting material up to a maximum depth of about 2.4 m.

1970-1007
BELL, R. G.
Fatty Acid Content as a Measure of the Odour Potential of Stored Liquid Poultry Manure
Poultry Sci. 49: 1126-1129
Abst: McQ & B B-286

Stored liquid manure is the source of agriculture's worst odor nuisances. In a series of experiments designed to secure criteria for tolerable concentrations, it was found that the fatty acid content, while not necessarily the cause of the odor, was an excellent indicator of its potential. Limits of 0.1 percent fatty acids content in design, and 0.2 percent fatty acids content for initiation of prosecution under air pollution legislation are proposed.

1970-1008
BENTON, Al
Manure a By-Product -- Not a Waste
CALF News 8: Feb. p. 6

The basic product value of manure is about $24 per ton. Its fertilizer value is $4 to 5. It has high nutritive value for refeeding. It has a value of $140/ton for producing yeast for poultry feed and is a food for fly maggots with a content of 62 percent protein and 9 percent fat.

1970-1009
BOYD, Claude E.
Vascular Aquatic Plants for Mineral Nutrient Removal from Polluted Waters
Econ. Botany 24: 95-103

Aquatic plants, particularly water hyacinth, remove large quantities of nutrients from water. Their introduction to accomplish this may be justified. The cost of their harvesting would be offset to some extent by their value as feedstuff. Problems involved include mosquito breeding -- with restrictions on the use of insecticides on feedstuffs -- and the economic necessity of sun-drying before dehydrating. The paper contains 31 references.

1970-1010
BRESSLER, Glenn O.
Drying Poultry Manure Inside the Poultry House
Agr. Engrg. 51: 136
Reprint: Poultry Digest 29: 232
Abst: McQ & B B-638; W71-02043

By means of fans placed ten inches above manure and moving air at 250 to 750 fpm, moisture can be removed economically. The dried manure, when ground and bagged, "should have excellent sales potential." Hauling costs are stated to be one-third those of conventional methods, and one-fifth those of handling liquid manure.

1970-1011
BURNETT, W. E. and DONDERO, N. C.
Control of Odors from Animal Wastes
ASAE Trans. 13: 221-224, 231 [ASAE Paper 68-909]
Abst: McQ & B B-044, G-041; W71-02624

Animal waste odors due to H_2S, NH_3, and various organic compounds carry over long distances and endure for long times. The paper discusses their elimination by chemical means. Masking agents and counteractants were found to be more effective than deodorants and digestive deodorants. Costs of 63 ¢ per 450 gal of liquid manure are quoted on the basis of experimental studies. The possibility of damage to the soil by repeated application has not been investigated.

1970-1012
CALVERT, C. C.; MORGAN, N. O.; and MARTIN, R. D.
House Fly Larvae: Biodegradation of Hen Excreta to Useful Products
Poultry Sci. 49: 588-589
Abst: McQ & B B-284; W71-00334

Seeding hen excreta with 1.5 fly eggs per gram produced the largest larvae; 4.5 eggs per gram gave the greatest loss in moisture and greatest nitrogen production but gave the lowest pupation and lowest total weight of pupae. Three eggs per gram seems to be optimum.

Obnoxious odor is reduced by the fourth day. The manure is odorless and friable by the eighth day.

1970-1013
CATH, William S.
Agricultural Waste Funding
Proc. Conf. on Agr. Waste in an Urban Environment. p. 99-106

Land use planning is seen as a basic necessity for any rational approach to agricultural problems. A quick survey, state by state, of studies in progress or planned is given. It is preferable to decrease waste or utilize waste rather than to merely dispose of it.

1970-1014
CLAYBAUGH, Joe W.

Agricultural Waste Research Needs
Proc. Conf. on Agr. Waste in an Urban Environment. p. 118-121
Reprint: Compost Sci. 11: Nov-Dec. p. 18-19 (1970)

Disposal should be a short-range objective. Composting, now more an art than a science, deserves study. Further investigations of two-layer lagoons with, perhaps, water from the top (aerobic) layer being used for poultry shed flushing; of lagoon liner requirements as a function of permeability; and of aeration capacity required for odor control as a function of climate are needed. Would a plastic bubble over the lagoon permit the capture of methane gas?

In the longer run, manure should be salvaged. The value of U. S. poultry manure, based on 8 ¢/lb for N and 6 ¢ per lb for P and K, is $40,000,000 per year. Trace elements which may be absent in chemical fertilizer would increase the figure. Work at Michigan State, Penn State, and elsewhere on the pasteurization and processing of wastes for livestock feed holds much promise.

1970-1015
CROSS, Otis E. and DURAN, Alvaro
Anaerobic Decomposition of Swine Excrement
ASAE Trans. 13: 320-322, 325
Abst: McQ & B B-045; W71-06453

"This paper presents a laboratory analysis on the anaerobic digestion of swine excrement as affected by temperature and loading rate."

1970-1016
DAVIDSON, J. A. and MACKSON, C. J.
Poultry Manure Handling by Indoor Septic Tanks (So-called "Indoor Lagoons").
Mich. State Univ. Ag. Ex. Sta. Rsch. Rpt. 117. p. 8-9
Abst: McQ & B E-193; W71-03557

Five years operation of indoor lagoons for a 300-chicken operation at Michigan State from 1961-1966 is described. Annual cleaning by a septic tank service truck of shallow pits subjected to various aeration processes was adequate. "The use of tanks ended in 1966 because of the move to a new poultry plant and recent emphasis has been on drying and recycling of the product in the feeding of poultry."

1970-1017
DIAL, Clyde J.
Funding Agricultural Waste Projects
Proc. of Conf. on Agr. Waste in an Urban Environment. p. 76-84

A brief summary of the history of Congressional action on the funding of solid-waste research, and of the subject matter of funded research projects is given. The possibility of "disposal co-operatives" similar to farm marketing cooperatives, but including also municipalities and industries is worthy of careful study.

1970-1018
DORNBUSH, James N.
State-of-the-Art -- Anaerobic Lagoons
2nd Intl. Symp. for Waste Treatment Lagoons. p. 382-387
Abst: McQ & B A-242

Properly designed anaerobic lagoons will control odors and stabilize wastes. The effluent will require further treatment. The mechanism of treatment involves two stages; in the first stage the organic matter undergoes breakdown with little reduction in BOD or COD; in the second, methane and CO_2 are released and the waste stabilizes.

Design criteria are empirical. The functioning is similar to that of a sludge digester. A starting-up is facilitated by seeding with methane-producing bacteria. Temperature must be above 15°C, thus regional connotations occur in design specifications. Research is needed to enhance the performance of this very effective process.

1970-1019
EL-SABBAN, F. F.; BRATZLER, J. W.; LONG, T. A.; FREAR, D. E. H.; and GENTRY, R. F.
Value of Processed Poultry Waste as a Feed for Ruminants
Jnl. Animal Sci. 31: 107-111
Abst: McQ & B B-226

Interest in the feeding of waste products arises from the possibility of disposal of the waste in a beneficial and economical manner, from the avoidance of pollution, and from the resulting freedom to shift crop land from feed production to food production.

Trials are described in which autoclaved, cooked, and dried poultry wastes were fed to sheep and steers.

1970-1020
FINCHER, G. Truman; STEWART, T. Bonner; and DAVIS, Robert
Attraction of Coprophagous Beetles to Feces of Various Animals
Jnl. Parasitology 56: 378-383
Abst: W71-00340

By studying traps baited with the dung of various animals in three different ecological settings in Georgia, the authors found that swine feces attracted the most species of coprophagous beetles. While some beetles serve as intermediate hosts of various helminths of domestic and wild animals, their service in preserving the nitrogen value of dung by prompt burial is valuable. Because of inadequate numbers of dung beetles in Australia, cattle dung remains on the ground surface for years "and has an effect on the pasture somewhat like a noxious weed because cattle will not graze on the rank growth around these dung pads." The paper lists 20 references.

1970-1021
FLEGAL, Cal J.; GOAN, H. C.; and ZINDEL, Howard C.
The Effect of Feeding Dehydrated Poultry Waste to Laying Hens on the Taste of the Resulting Eggs
Mich. State Univ. Ag. Ex. Sta. Rsch. Rpt. 117. p. 34-38
Abst: McQ & B E-198; W71-03563

After chickens had been on diets containing 0, 10, 20, and 30 percent DPW, eggs were collected, hard boiled, and fed to taste panels. In a comparison of control vs 10 percent DPW eggs, 58 percent liked and 26 percent disliked the control while 64 percent liked and 24 percent disliked the 10 percent DPW. In comparing control with 20 percent DPW eggs, 68.5 percent liked and 18.4 percent disliked the control while 52.6 percent liked and 10.6 percent disliked the 20 percent DPW. In comparing control with 30 percent DPW eggs, 66.7 liked and 16.7 percent disliked the control while 72.7 percent liked and 16.7 percent disliked the 30 percent DPW. The results are not statistically significant.

1970-1022
FLEGAL, Cal J. and ZINDEL, Howard C.
The Utilization of Poultry Waste as a Feedstuff for Growing Chicks
Mich. State Univ. Ag. Ex. Sta. Rsch. Rpt. 117. p. 21-28
Abst: McQ & B E-196; W71-03560

Dried manure from caged layers was fed to two groups of chicks as 0, 5, 10, and 20 percent of the ration. A fifth ration contained 20 percent DPW and 4 percent stabilized fat. Weight gains on the fifth ration were better than on the other four. Efficiency of feed utilization was inversely related to percentage of DPW fed. These tests and others reported in the literature indicate that DPW is a low-energy product.

1970-1023
FLEGAL, Cal J. and ZINDEL, Howard C.
The Result of Feeding Dried Poultry Waste to Laying Hens on Egg Production and Feed Conversion
Mich. State Univ. Ag. Ex. Sta. Rsch. Rpt. 117. p. 29-30
Abst: W71-03561

Thirteen possible diets -- a control, control + DPW (10, 20, and 30 percent), control + DPW + calcium and phosphate + methionine, and control + DPW + calcium and phosphate + methionine + two percent fat -- were fed layers on test for 139 consecutive days. Composition of the rations and kilograms of feed per dozen eggs are tabulated. These latter ranged from 1.91 for control + 10 percent DPW to 2.55 for control + 30 percent + calcium and phosphate + methionine.

1970-1024
FLEGAL, Cal J. and ZINDEL, Howard C.
The Effect of Feeding Dehydrated Poultry Waste on Production, Feed Efficiency, Body Weight, Egg Weight, Shell Thickness and Haugh Score
Mich. State Univ. Ag. Ex. Sta. Rsch. Rpt. 117. p. 31-33
Abst: McQ & B E-197; W71-03562

On a 366-day trial chickens were fed 0, 10, 20, and 40 percent DPW + one percent stabilized fat and 40 percent DPW + 5 percent stabilized fat in protein-nitrogen equal rations. The ration, egg production, feed efficiency (pounds of feed per dozen eggs), weight gain, egg weight, shell thickness and Haugh score are tabulated. At 20 and 40 percent DPW, protein efficiency and weight gain dropped off. Additional fat restored these values partially.

1970-1025
FLEMING, Bill
Beef Re-Visits Feedlot of the '70's
Beef 6: Oct. p. 6, 7, 10

Iowa Beef Packers at Denison, Iowa, began testing confined cattle feeding over an oxidation ditch in November, 1969. First year results were most promising. Cattle in confinement had better winter and summer gains than control cattle in an open pen. The oxidation ditch was redesigned to be continuous rather than to consist of two "racetracks" side-by-side. Aerators were moved to the center to avoid centrifugal interference with uniform action. Water was added to compensate for evaporation when necessary. Empirical adjustments were made to secure optimum functioning of the ditch.

1970-1026
FONTENOT, J. P.; TUCKER, R. E.; HARMON, B. W.; LIBKE, K. G.; and MOORE, W. E. C.
Effects of Feeding Different Levels of Broiler Litter to Sheep (Abst)
Jnl. Animal Sci. 30: 319
Abst: McQ & B B-223

Wood-shavings litter sterilized at 150°C for four hours was fed to sheep as 0, 25, 50, or 75 percent of diets calculated to be nutritionally similar. No gross toxological effects were observed. There were substantial feed refusals only when 75 percent litter was included in the ration. "No adverse effects of feeding litter were evident from the detailed necropsies and studies of the histological sections."

1970-1027
FRINK, C. R.
Animal Waste Disposal
Compost Sci. 11: Nov-Dec. p. 14-15
Abst: McQ & B B-678

Costs exceed value, but, in considering all methods of disposal, land spreading, with credit for the fertilizer value, appears to be the least costly. Spreading as liquid manure on forests is suggested when crop land is unavailable.

1970-1028
GILLILAND, Jay
Simple System for Aerating Manure Lagoons
DeKalb Mgmt. News and Views v. 5, No. 2
Reprint: Poultry Digest 29: 330-331

To aerate a 100 by 200 ft lagoon 12 ft deep, a pipeline on floats was installed. A five hp pump supplies six nozzles spraying water into the air over the pond for $2.20 per 24-hr day. Settled manure is digested anaerobically; the aeration reduces odors.

1970-1029
GOLUEKE, Clarence G. and McGAUHEY, P. H.
Comprehensive Studies of Solid Waste Management. First Annual Report
USPHS Pbln. No. 2039 xx + 202 p.
Abst: McQ & B D-037

During the first year (1966-67) of a comprehensive study of solid waste management by the University of California under the sponsorship of the Bureau of Waste Management, USPHS, a bibliographic search was conducted and investigations were launched in socio-economic studies and in the processes of incineration, pyrolysis, composting, treatment of wastes as components of sewage, wet oxidation, and biological fractionation. Particular importance was attached to this latter method inasmuch as it would provide a return to the natural equilibrium of recycling of wastes through the activities of microorganisms. Primary emphasis is placed on the management of municipal solid wastes. One hundred sixty-eight references are listed.

1970-1030
GOLUEKE, Clarence G. and McGAUHEY, P. H.
Comprehensive Studies of Solid Waste Management. Second Annual Report.
USPHS Pbln. No. 2039. xvii + 245 p.
Abst: McQ & B D-037

During phase II (June 1967 to September 1968) of the intensive study of solid waste disposal in the San Francisco Bay area emphasis continued to be placed on the transportation and ultimate disposal of municipal and industrial wastes. Land spreading of animal wastes, while not unobjectionable, left them much less pressing a problem than municipal and industrial wastes.

The economics and technology of five processes were treated extensively. While animal wastes were considered only to the extent of observing that chicken manure is an excellent source of the nitrogen required in anaerobic digestion, the discussions are of transfer value in animal waste studies. The methods, with page citations for economics and technology respectively are: anaerobic digestion, 67-75 and 112-148; composting, 63-66 and 149-153; wet oxidation, 79-82 and 154-170; pyrolyzation-incineration, 82-83 and 171-175; and biofractionation, 75-79 and 176-185. A list of 86 references is included.

1970-1031
HARMON, B. W.; FONTENOT, J. P. ; and WEBB, K. E., Jr.
Effect of Processing Methods of Broiler Litter on Nitrogen Utilization
    by Lambs (Abst)
Jnl. Animal Sci. 31: 243
Abst: McQ & B B-229

Litter was (1) autoclaved under steam pressure of 1.06 kg/cm^2 for 40 min, (2) heated in forced-draft oven at 150°C for four hours, and (3) acidified with 30 ml 1.0 N H_2SO_4 per 100 g of litter followed by process (2). Nitrogen retention was greater for animals fed a control ration than for those fed any of the processed litter. The methods of processing litter all produced about the same results.

1970-1032
HART, Samuel A.
Animal Manure Lagoons, A Questionable Treatment System
2nd Intl. Symp. for Waste Trtmt. Lagoons. p. 320-326
Abst: McQ & B A-239; W71-07116

Manure lagoons are essentially sludge digesters rather than polishing devices for effluent.

The anaerobic lagoon produces odor, may contribute to groundwater infiltration, and may overflow releasing a high-BOD supernatant. Floating mats of feathers may become a breeding place for flies, but floating covers of hay stems and grain hulls will not, and may reduce odors. Anaerobic lagoons need cleaning to maintain their proper volume. "Seed" should be left when cleaning.

Oxidation ditches and facultative lagoons are discussed and design parameters are given and/or cited in the 27 references.

"Lagoons and oxidation ditches are not magic wands, but they can be very reasonable manure processing units."

1970-1033
HARTMAN, Roland C.
John Prohoroff: Biologics Pioneer
Egg Industry 3: June p. 16-22
Reprint [As Biological Fly Control Works] Poultry Digest 29: 262-265

John PROHOROFF of San Diego County, California, uses predators and parasites of flies to keep his chicken sheds essentially fly-free. Beetles and their larvae (meal worms) eat fly eggs and larvae. The beetles live in the composted sub-base of the droppings and keep the mass aerated seeking fly larvae which hatch from the eggs laid on wet manure. Certain wasps are also effective.

Final disposal is by composting and sale for fertilizer.

1970-1034
HENSLER, R. F.; OLSEN, R. J.; WITZEL, S. A.; ATTOE, O. J.; PAULSON, W. H.; and JOHANNES, R. F.
Effect of Method of Manure Handling on Crop Yields, Nutrient Recovery and Runoff Losses
ASAE Trans. 13: 726-731 [ASAE Paper 69-468]
Abst: McQ & B B-043, G-061

While fresh manure has the best fertilizer value, it may be necessary to store manure while the ground is frozen or in crops. For best nitrogen retention, manure should be kept moist and incorporated in the soil without being permitted to dry. Anaerobic storage preserves fertilizer value better than aerobic storage does.

1970-1035
HERR, Glenn H.
Under-Cage Manure Drying System Solves Odor Problem
Farm Service Bull. Jul-Aug.
Reprint: Poultry Digest 29: 476-479
Abst: W71-02696

"The theory that manure in a deep pit is self-disintegrating and that pits never need cleaning has proven false." Several wet-handling methods -- lagoons, irrigation, and honey wagons -- having proved to be unsatisfactory, and sewage treatment, incineration, and burying being deemed impractical and expensive, drying by stirring and forced ventilation was adopted by a Pennsylvania egg producer. Cost data are given.

1970-1036
HERR, Glenn H.
Identifying Agricultural Waste Problems: Poultry
Penn. Conf. on Agr. Waste Mgmt. p. 35-38

The speaker, associated with a laying hen complex of 360,000 hens which air dries its waste for use as fertilizer, advocates more practical research in making wastes profitable.

1970-1037
HERR, Glenn H.
Agricultural Waste Research Needs
Proc. Conf. on Agr. Waste in an Urban Environment. p. 109-117
Reprint: Compost Sci. 11: Sept-Oct. p. 8-11 (1970)
Abst: W71-06452

Liquid handling is not considered to be a satisfactory long-range solution for poultry waste disposal. Fan-drying of manure in the poultry shed with cleanout about every five days produced a semi-solid (28-35 percent moisture) product which was easy to handle, had little or no odor, had no restrictions on weather or seasonal disposal, had no great labor problems, and has some as yet unestablished value. The cost is about 1/3 ¢ per dozen eggs.

"Dehydration is our future challenge." The pasteurized and/or sterilized product of dehydration should have value for re-feeding. Production and use of methane gas deserves further study.

1970-1038
HOVENDEN, Tom
Coliformally Speaking Ducks Stink!
CALF News 8: Dec. p. 46

Research is quoted to the effect that the total coliforms discharged per day (in millions) are: humans 1950, cattle 5428, and ducks 11,088 per head. Coliform counts as indicators of municipal and-or agricultural pollution may overstate the contribution.

1970-1039
HYSLOP, N. St. G.
The Epizootiology and Epidemiology of Foot and Mouth Disease
Advances in Vet. Sci. 14: 261-307

In this well-documented study of foot and mouth disease, the transmissibility of the virus by urine and feces is discussed. The virus may become detectable in the feces several days before clinical signs are evident in the animal. Pigs in particular may spread the disease in this manner before an outbreak has been diagnosed. Stacked manure, when allowed to ferment naturally, becomes free of the virus after about eight days.

1970-1040
JACKSON, Sally W.; LANGLOIS, B. E.; and JOHNSON, T. H.
Growth of Microorganisms in Fresh Chicken Manure under Aerobic and Anaerobic Conditions
Poultry Sci. 49: 1749-1750
Abst: McQ & B B-292

Poultry manure, which can contain more than 13 percent uric acid, can be fed to ruminants for utilization of the nitrogen content. Uric acid is toxic to poultry. Attempts are being made to overcome this by fermentation of the manure. Preliminary findings indicate that aerobic bacteria, but not anaerobic, can survive in chicken manure.

1970-1041
KEETON, L. L.; GRUB, Walter; WELLS, Dan M.; MEENAGHAN, George F.; and ALBIN, Robert C.
Effects of Manure Depth on Runoff from Southwestern Cattle Feedlots
ASAE Paper 70-910. 7 p.
Abst: McQ & B G-091

On the feedlots of the High Plains of Texas manure is usually allowed to accumulate in place with removal occurring once or twice per year. In the dry climate dehydration occurs with resulting cessation of decomposition. Precipitation restores the manure to essentially its original condition thus creating a high pollution potential. The report considers quality and quantity of runoff in comparing laboratory determinations with field results.

"The quantity of runoff from a wet manure pack is independent of its depth. Runoff quantity from dry manure is partially dependent on manure depth, feedlot slope, and rainfall intensity. The quality of feedlot runoff is primarily a function of the moisture content of the manure, the rainfall intensity, and the feedlot slope."

1970-1042
KEHR, William Q.
Microbial Degradation of Urban and Agricultural Wastes
In: C. L. SAN CLEMENTE (Edit.): Environmental Quality: Now or Never
Mich. State Univ. p. 184-191

This paper reports on the status of five studies in which the Bureau of Solid Waste Management is cooperating. Composting, while technically successful, has been financially unrewarding. A project for the conversion of organic wastes to yeast in two stages, hydrolysis and fermentation, has much potential. Further study of the processes will be necessary before reliable cost analyses can be made.

1970-1043
KING, Thomas
Identifying Agricultural Waste Problems: Livestock
Penn. Conf. on Agr. Waste Mgmt. p. 39-40

Economically, mineral fertilizers are sold so cheaply that manure cannot compete. Land holdings are inadequate in size. Water and air pollution occur. Under many circumstances lagooning is not a satisfactory means of disposal.

"Properly treated, animal wastes have been demonstrated to be a beneficial source of feed for animals, poultry, and even fish. . . Thus far, however, most investigators have been reluctant to really delve into this area of research mainly for two reasons: (1) the checks and restrictions placed on them by certain governmental regulatory agencies responsible for public health and safety; and (2) lack of knowledge regarding the effect of such practices on consumers' future eating habits."

1970-1044
KNAPP, Carol E.
Agriculture Poses Waste Problems
Environ. Sci. and Tech. 4: 1098-1100
Abst: McQ & B B-111

The magnitude of American manure production is emphasized. Solutions include drying, shreading, composting, subsod injection, and the plow-furrow-cover procedure.

1970-1045
KNECHT, Robert W.
Municipal Viewpoint
Proc. of Conf. on Agr. Waste in an Urban Environment p. 48-50

More consideration should be given to the joint disposal of municipal and agricultural solid wastes. The combined wastes make better compost than either alone.

1970-1046
KOELLIKER, J. K. and MINER, J. Ronald
Use of Soil to Treat Anaerobic Lagoon Effluent: Renovation as a Function of Depth and Application Rate
ASAE Trans. 13: 496-499 [ASAE Paper 69-460]
Abst: McQ & B B-047, G-059

The goal of land spreading is to obtain the maximum reduction of pollution consistent with maintaining the ability of the soil to handle the load. Crops remove some of the nutrients. Phosphorus is removed near the surface by chemical action of clay layers. Denitrification may be effective if the subsoil can be kept wet.

1970-1047
LAAK, R.
Cattle, Swine and Chicken Manure Challenges Waste Disposal Methods
Water and Sewage Works 117: 134-138
Abst: McQ & B A-230; W70-06866

LAAK reviews the literature (30 references), tabulating statistics on animal population, manure production, manure characteristics, and pollution potential. Methods of manure disposal are listed and cost considerations are discussed.

1970-1048
LARSON, Russell E.
Searching for Solutions
Penn. Conf. on Agr. Waste Mgmt. p. 3-19

LARSON summarizes waste quantities in Pennsylvania by categories and locations. Problems arise from changes in agriculture (concentrations of stock and processing) and in people (expanding suburbia and no personal experience with farming).

Approaches to solutions suggested are research in recycling wastes with horticultural wastes becoming animal food and the air drying of poultry manure to provide fertilizer for lawns, strip-mined areas (800 lb/acre proposed) and highway rights-of-way.

1970-1049
LAW, James P., Jr. and BERNARD, Harold
Impact of Agricultural Pollutants on Water Users
ASAE Trans. 13: 474-478 [ASAE Paper 69-235]
Abst: McQ & B B-046, G-052; W71-02687

"Feedlot runoff is a source of high concentration of bacteria normally considered as indices of sanitary quality. Other pollutants arising from animal wastes are the nutrient compounds of nitrogen and phosphorus and mineral salts." While moderate enrichment of receiving waters may promote fish, larger amounts lead to algae which, after death, have a heavy oxygen demand. Slug flows may produce fish kills.

1970-1050
LOEHR, Raymond C.
Drainage and Pollution from Beef Cattle Feedlots
ASCE Proc. 96: SA 6: 1295-1309
Abst: McQ & B B-094; W71-10994

To minimize the pollution potential of feedlots, minimize the runoff from them by diversion of runoff from non-feedlot areas, by use of retention ponds, and by spreading the liquid and solid wastes on agricultural land. Compact, fast draining feedlots are preferable. A state-of-the-art survey on runoff quantity and quality is given. The paper lists 26 references.

1970-1051
LOEHR, Raymond C.
Treatment and Disposal of Animal Wastes
Indust. Water Engrg. 7: Nov. p. 14-18
Abst: McQ & B F-088; W71-02688

LOEHR discusses the relative merits of nine systems of animal waste disposal. The first three, in each of which the manure is handled as a semi-solid, are land disposal without storage or with storage in an anaerobic tank, storage in an aerated tank, or a combination of anaerobic tank followed by aerobic tank. Systems 4 and 5 are in-house: oxidation ditches and deep pits. System 6 involves separation of wastes into liquid and solid components. Systems 7, 8, and 9 are drying, composting, and incineration. Runoff from open lots should be intercepted in retention ponds and kept out of streams by land spreading and/or evaporation.

1970-1052
LOEHR, Raymond C.
Disposal of Solid Agricultural Wastes -- Concepts and Principles
Proc. Conf. on Agr. Waste in an Urban Environment p. 126-134
Abst: W71-07556

Composting is usually facilitated by blending manure with sawdust, corn cobs, paper, and municipal refuse. Technically it is successful; economically it is not.

Drying and dehydration produce an end product suitable as a soil conditioner or for refeeding. The market potential is unknown.

Refeeding holds much promise. Some problems remain to be investigated further.

Incineration and pyrolysis may provide solutions in some locations.

"Land disposal always will be a most important aspect of agricultural solid waste disposal."

Solutions must have technical merit and must integrate into the full animal operation. Disposal need not show a profit, but the overall system, including disposal, must be optimized.

1970-1053
LOEHR, Raymond C. and SCHULTE, Dennis D.
Aerated Lagoon Treatment of Long Island Duck Wastes
2nd Intl. Symp. for Waste Trtmt. Lagoons p. 249-258
Abst: McQ & B A-238; W71-07108

Some seven million ducks per year (65 percent of U. S. total) are raised in Suffolk County, Long Island, New York. Pollution of shellfish, fin fish, recreational areas, and invading suburbia was resulting from the 4-to 96-gpd per duck water usage plus the slug flows of manure washed to surface water by precipitation.

Control is by diverting water for duck usage to controlled ponds, then treating the pond effluent by five-day retention in an aeration lagoon followed by an additional settling pond and chlorination of the final effluent. Studies, scheduled to be completed in early 1971, were underway to find a satisfactory method of phosphorus removal. Costs with phosphorus removal were expected to be about twice those without. Eleven references are included.

1970-1054
LOWMAN, B. G. and KNIGHT, D. W.
A Note on the Apparent Digestibility of Energy and Protein in Dried Poultry Excreta
Animal Production 12: 525-528
Abst: McQ & B B-319

Dried poultry excreta provides nitrogen which is efficiently utilized by sheep at a cost of about one-third, on a protein-equivalent basis, that of fish meal. The copper content of the poultry manure, while almost twice that of barley (73 compared with 48 ppm), was less available to sheep than was that of barley (17.6 compared with 24.5 ppm).

"It is concluded that, as far as copper levels are concerned, dried poultry excreta are safe for ruminants, and are a source of cheap protein."

1970-1055
LUKE, George W.
Agricultural Waste Research Needs
Proc. Conf, Agr. Waste in an Urban Environment p. 140-141
Abst: W71-07558

Land disposal risks stream pollution and odors.

Manure from race tracks in New Jersey is trucked to mushroom farms.

1970-1056
MACLINN, Walter A.
Agricultural Waste Research Needs
Proc. Conf. Agr. Waste in an Urban Environment p. 218-220

Disposal must not be the sole research aim. Biological resources should be conserved and returned to nature by techniques other than land spreading. The best methods of doing so remain to be determined. With composting, drying and dehydration, and incineration the volume is reduced prior to returning the wastes to the soil. Faster processes and/or odor reduction are needed.

Cost analyses of the processes, reuse values, and potential markets need to be explored. The author states without amplification that "re-feeding of animal wastes is the least desirable reuse technique."

1970-1057
McALLISTER, J. S. V.
Collection and Disposal of Farm Wastes
Water Poll. Control 69: 425-429
Abst: McQ & B A-227; W71-04486

Practices in Northern Ireland are summarized. "At present practically all the slurry collected in the British Isles is disposal of by direct application to the land after a relatively short, 1 to 13 weeks, storage period." The usual problems of odors, excessive nutrients in areas over-loaded with manure, and potential health hazards are discussed. Earthworm kills by excessive applications of slurry have been observed; in such cases, however, the reduction in earthworms has proved to be temporary and a rapid increase to or beyond the original numbers occurs.

Separation of solid and liquid fractions with subsequent composting or incineration of the solids and aerobic treatment of the liquids would provide a possible improvement over current practice. Alternative methods are mentioned without elaboration.

1970-1058
McINTIRE, Clifford G.
Agricultural Waste Legislation
Proc. Conf. Agr. Waste in an Urban Environment p. 153-159

Sound consideration, rather than hysteria, should govern in enacting environmental law. New laws should not be added "just for fanfare and publicity." Readily defined objectives and equity are needed.

1970-1059
MEENAGHAN, George F.; WELLS, Dan M.; ALBIN, Robert C.; and GRUB, Walter
Gas Production from Beef Cattle Wastes
ASAE Winter Meeting. Paper 70-907. 15 p.
Abst: McQ & B G-088

The experimental procedures employed and the results obtained in laboratory testing of a two-stage isothermal anaerobic digestion of cattle manure are described and discussed. Such a system is concluded to be "technically feasible and [useful] for obtaining nominal treatment of beef cattle wastes. Even with optimal conditions per stage such a system will not be sufficient for complete treatment."

1970-1060
MIDWEST PLAN SERVICE
Handling Liquid Manure
Agr. Engrs. Digest AED-8 4 p. [Revision of 1966 publication]

Advantages of liquid manure handling include the preservation of nutritive and organic value, some saving in labor, flexibility in scheduling disposal time, odor reduction by keeping manure under a water cover, and economy in that disposal equipment may be owned jointly by a group of neighbors. Facilities and equipment needed include a water-tight storage container, pumps, agitators, available land, and honeywagons or pipe and nozzles. Storage requirements are listed and methods of operation are described.

1970-1061
MIDWEST PLAN SERVICE
Handling Swine Manure
Agr. Engrs. Digest AED-11 4 p. [Revision of 1969 publication]

Solid manure handling requires a minimum of equipment and conserves the soil-building properties of the manure. Runoff from manure piles must be kept out of streams. For liquid manure handling, see AED-8 [1970-1060].

1970-1062
MIDWEST PLAN SERVICE
Oxidation Ditch for Treating Hog Wastes
Agr. Engrs. Digest AED-14 4 p.

The advantages of oxidation ditches include odor reduction in buildings and during transport and spreading. The total waste volume is reduced, the manure is rendered unattractive to rodents and insects, the winter ventilation requirements are lowered, and the operation is simple.

Disadvantages include higher capital and operation costs. Down-time can be catastrophic in that toxic gases can accumulate. Major construction is required in adapting existing buildings for oxidation ditches. Foaming can be a problem.

Design and operation are discussed. Cost data and a sample design are included. Final disposal must not be to a stream. A lagoon and irrigation are recommended.

1970-1063
MILLER, R. W.
Larvicides for Fly Control -- A Review
Bull. Entom. Soc. Amer. 16(3): 154-158
Reprinted as Fecal Residues from Larvicides -- Poultry and Cattle,
USDA ARS 44-224, p. 33-41
Abst: McQ & B A-205

The historical development and present (Feb. 1971) status of larvicides for control of fly species in domestic animal manures are reviewed. Addition of the larvicide as a feed additive has the advantages of relative simplicity of mixing a determinate amount into a poultry ration or the concentrate portion of a cattle ration, the economy of avoiding manure spraying, and the potential for treating droppings of cattle on range. However, the compound must be palatable, must have no detrimental effect on the animal to which it is fed, and must leave no injurious residue in tissue, milk, or eggs. "Few insecticides have all the above characteristics." Seek current information before feeding any larvicide.

1970-1064
MILLER, R. W.; DRAZEK, P. A.; MARTIN, M. S.; and GORDON, C. H.

Feeding of Micro-Encapsulated Gardona for the Control of Fly Larvae
in Cow Manure
Jnl. Dairy Sci. 53: 684

The feces from dairy cows fed an average of 64 ppm (air-dry ration basis) of Gardona supported only six percent as many fly larvae as the feces of control cows. Less than 0.001 ppm of Gardona appeared in the milk of cows fed up to 108 ppm of the insecticide.

1970-1065
MILLER, R. W.; GORDON, C. H.; BOWMAN, M. C.; BEROZA, Morton; and
MORGAN, N. O.
Gardona as a Feed Additive for Control of Fly Larvae in Cow Manure
Jnl. Econ. Entom. 63: 1420-1423
Abst: McQ & B B-604

A series of experiments in feeding Gardona, an organophosphorus insecticide, to dairy cattle is reported. When fed at levels of 22, 37, and 48 ppm of the air-dry ration, Gardona killed 94 percent or more of the larvae of house flies seeded onto the feces. Losses of about 99.7 percent of the Gardona fed occurred in the passage through the cow's digestive tract. Encapsulation may be a possibility for reducing the loss.

1970-1066
MILLER, R. W.; GORDON, C. H.; MORGAN, N. O.; BOWMAN, M. C.; and
BEROZA, Morton
Coumaphos as a Feed Additive for the Control of House Fly Larvae in
Cow Manure
Jnl. Econ. Entom. 63: 853-855
Abst: McQ & B B-598

The paper reviews the use of insecticides as feed additives (14 references) and reports on the effectiveness of Coumaphos, an organophosphorus insecticide, when fed to lactating dairy cows. Ratios of larvae killed increased with the concentration of Coumaphos fed, reaching 100 percent at about 144 ppm. Additional study and field testing are called for.

1970-1067
MINER, J. Ronald
Agricultural (Livestock) Wastes. [In a Review of the 1969 Literature
on Wastewater and Water Pollution Control]
WPCF Jnl. 42: 1171-1179
Abst: McQ & B B-083

The Cornell Conference on Animal Waste Management (46 papers) and the WPCA Conference on runoff from cattle feedlots highlighted the year's activities. MUEHLING's paper on Swine Housing and Waste Management [1969-1064] with more than 125 references and JOHNSON and MOUNTNEY's Bibliography of Production, Utilization and Disposal of Poultry Manure [1969-1037] with 596 references were cited as were other reports on the state of the art of animal waste treatment. Subheadings for the classification of papers abstracted are: Manure Handling Systems, Manure Gases and Odors, Waste Characterization, Cattle Feedlot Wastes, Application of Wastes to Croplands, and Waste Treatment Studies. Sixty-five references are listed.

1970-1068
MINER, J. Ronald; BAUMANN, E. R.; WILLRICH, T. L.; and HAZEN, T. E.
Pollution Control -- Feedlot Operations
WPCF Jnl. 41: 391-398
Abst: McQ & B B-082

"The obvious answer to shrinking profit margins is volume production." This leads to mechanization which requires confinement. "The population equivalent figures, so common in the popular press, only distort the actual picture." "Among the problems associated with a more sophisticated disposal scheme is manure collection. The collection of manure from an open feedlot has not proved amenable to traditional solid handling techniques. . . Odor control technology has not kept pace with technology in confinement livestock production."

1970-1069
MINSHALL, Neal E.; WITZEL, Stanley A.; and NICHOLS, Merle S.
Stream Enrichment from Farm Operations
ASCE Proc. 96: SA 2: 513-524. SA 5: 1291
Closure 97: SA 2: 230
Abst: W71-02035

Based on research in Wisconsin, the authors favor land spreading of wastes subject to specified precautions. "Lagoons are currently not considered generally acceptable for farm waste disposal." Among the conclusions stated were that nutrient losses in surface runoff from plots having manure applied in summer and incorporated into the soil were less than those from check plots which received no manure. Manure should be spread only when the ground is not frozen and should be incorporated into the soil as soon as possible. Facilities for winter storage of manure would be required.

1970-1070
MOORE, J. D. and ANTHONY, W. Brady
Enrichment of Cattle Manure for Feed by Anaerobic Fermentation (Abst)
Jnl. Animal Sci. 30: 324
Abst: McQ & B B-224

In fermenting cattle manure anaerobically, the pH drops from 6.25 to 4.0 within 16.5 hours when the manure is incubated at 37°C. By adjusting the pH with ammonia daily for three days, the crude protein level may be raised from 16.99 percent to 43.26 percent and the amino acids may be increased by over 20 percent.

1970-1071
MOORE, James A. and BROOKER, Donald B.
The Future of Farm Animal Waste Management
Agr. Engrg. 51: 414, 417
Abst: McQ & B B-641

Improved rations can be expected to produce a richer manure. This may be refed or the nutrient, antibiotic, and vitamin content may be salvaged. Livestock may well be raised in complete confinement with no runoff. Zoning with several miles of cropland, partly irrigated with animal wastes, separating town and feedshed is to be anticipated. "When land is at a premium, the Southwest may become the livestock center of the United States."

Lagoons may well be replaced by digesters, with these latter being warmed by burning the gas they generate. "Work on today's problems with today's technology."

1970-1072
MORGAN, N. O.; CALVERT, C. C.; and MARTIN, R. D.
Biodegrading Poultry Excreta with House Fly Larvae: The Concept and Equipment
USDA ARS 33-136 3 p.

The ability of house fly larvae to biodegrade chicken manure into a fertilizer or soil conditioner and a feed supplement is under study at Beltsville. "The house fly larvae were selected for testing because they can develop in organic wastes. Fly eggs placed on fresh waste hatch within 24 hours, and the young larvae immediately begin feeding and tunneling into the medium. Then after 6-7 days the larvae migrate to a drier site where they pupate." Equipment adequate for the process is described and illustrated diagramatically. The excreta from 100,000 hens could produce between 500 and 1000 pounds of pupae daily. Dried pupae have been shown by CALVERT et al [1969-1017] to be a satisfactory source of protein for growing chicks.

1970-1073
MUEHLING, Arthur J.
Gases and Odors from Stored Swine Wastes
Jnl. Animal Sci. 30: 526-531
Abst: McQ & B B-225; W71-00326

The various gases which occur are listed and described. In a well-operated confinement unit no gas reaches harmful concentrations for pigs or humans. With breakdown of ventilation or with stirring of manure, however, harmful or lethal buildups may occur. "It may be possible to apply the industrial methods of treating odors; namely, dilution, absorption, adsorption, masking, counteraction and burning to the control of odors from stored manure."

1970-1074
MURRAY, Clifton A.
Agricultural Waste Legislation
Proc. Conf. Agr. Waste in an Urban Environment p. 142-143

A hog farm within a quarter mile of town relies on an oxidation ditch to control odors. By maintaining a velocity of two mph and designing to eliminate any dead-water corners, it has been effective.

1970-1075
PARSONS, Robert A.; PRICE, Fred; and FAIRBANK, W. C.
Poultry Manure Lagoon Design
Univ. of Cal. Ag. Ext. Service, Spl. Pbln. Stanislaus County Office
Reprint: Poultry Digest 29: 485-488
Abst: McQ & B E-258; W71-02700

Specifications for designing poultry lagoons are given in detail. They should be used "only in rural areas that are tolerant of varied but dilute odors of farm production." Overloading is considered to be "about the only cause of lagoon malfunctions." Maintenance hints and cost data are included.

1970-1076
PFEFFER, John T.
Anaerobic Lagoons -- Theoretical Considerations
2nd Intl. Symp. for Waste Trtmt. Lagoons p. 310-320

The biochemical transformations consist of two distinct steps: acid fermentation and methane fermentation. The acid fermentation is an essentially constant-BOD process. Stabilization of the waste occurs only with the release of methane. Similarities to the operation of a rumen are cited. "The anaerobic lagoon system has definite advantages in terms of costs over many other wastewater treatment systems. However, its application is not universal. There are many wastewaters that should not be treated by this system. The toxicity problems resulting from heavy metals, sulfides and ammonia are not easily controlled in this system. Also the odor associated with hydrogen sulfide release may be unacceptable. The effect of temperature on methane fermentation must be considered."

1970-1077
PORTER, Gilbert H.
Agricultural Waste Research Goals and Needs
Penn. Conf. on Agr. Waste Mgmt. p. 69-73

PORTER lists sixteen high-priority research topics in agricultural waste management, including the study of recycling or other use for poultry manure, and calls for reorientation in outlook and funding toward obtaining quality rather than quantity as a primary goal.

1970-1078
POS, Jack
Liquid Manure Aeration Systems
Canad. Poultry Review. Mar.
Reprint: Poultry Digest 29: 223-224

Ultimate disposal of poultry manure being to the land, storage is required. Storage intensifies odor problems. It is usually easier to aerate -- mechanically (oxidation ditch), hydraulically, or pneumatically -- than to dry manure.

1970-1079
PRICE, Fred
Manure Mites in Integrated Fly Control
Poultry Letter 20 Nov.
Reprint: Poultry Digest 30: 68

In Southern California naturally occurring predators (such as beetles, mites, and ants) and parasitic wasps are being used in fly control on poultry manure. "Manure mites do not get on birds and people, but remain in the manure at all times." For mites to be effective avoid water spillage and be judicious in use of pesticides.

(See other notes on p. 25 and 141 of the same volume).

1970-1080
RILEY, Charles T.
Current Trends in Farm Waste Disposal
Water Poll. Control 69: 174-179
Abst: McQ & B A-305, A-542; W70-08333

Handling of farm wastes in the UK is usually by one of the following methods:

1. Solid - Use bedding to absorb the liquid. Store the wastes in a pit (lined or unlined) six to nine months. Spread on land semiannually.

2. Semi Solid - Handle manure, without use of bedding or dilution water, by use of a spreader. Odors and muddy fields cause problems.

3. Liquid applied by tanker - Storage is required.

4. Organic irrigation - Liquid applied by spray nozzle.

There is a tendency to return to solid handling. Temporary aeration of slurries by use of blowers has promise of eliminating odors during spreading. Refeeding, wet oxidation, and incineration have long-range potential.

1970-1081
ROBERTSON, L. S. and WOLFORD, John
The Effect of Application Rate of Chicken Manure on the Yield of Corn
Mich. State Univ. Ag. Ex. Rsch. Rpt. 117. p. 10-15
Abst: McQ & B E-194; W71-03558

The chemical content of chicken manure, on an "as-received" basis, and plant nutrients in pounds for various quantities of manure are tabulated. The use of high rates of chicken manure significantly reduces the pH of the soil; significantly increases available P, available K, magnesium, nitrate, and carbon; tends to increase calcium, zinc, and copper; and has no effect on manganese.

1970-1082
SANNER, W. S.; ORTUGLIO, Charles E.; WALTERS, J. G.; and WOLFSON, D. E.
Conversion of Municipal and Industrial Refuse into Useful Materials
by Pyrolysis
USDI Bur. of Mines Rpt. of Investigations 7428. 14 p.

This report describes the pilot pyrolysis plant of the Bureau of Mines at Pittsburgh and tabulates the breakdown products of experiments on municipal solid waste and two selections of industrial wastes. "The results of these experiments strongly suggest that the pilot plant should be modified and expanded to provide for continuous operation so that reliable data can be obtained for projecting costs of large-scale pyrolysis plants. The effect that drying the raw refuse before pyrolysis would have on the yield and the quality of products should also be studied."

1970-1083
SCALF, Mario R.; DUFFER, W. R.; and KREIS, R. Douglas
Characteristics and Effects of Cattle Feedlot Runoff
Proc. 25th Purdue Ind. Waste Conf. p. 855-864
Abst: McQ & B C-335

Quality of runoff from a 12,000-head commercial cattle feedlot in a pond and in a reservoir to which overflow from the pond could drain through a two-mile grass-grown ditch are discussed and tabulated. Extraneous drainage was diverted around the feedlot and comparisons were possible with a second reservoir of approximately the same age, size, and drainage basin area without feedlots on its watershed.

The concentration of organic matter, solids, and nutrients in the feedlot runoff was high, but variable. The pond reduced sediment, BOD, and COD by 80 to 90 percent. The ditch had little additional effect. Fish kills in the reservoir were due primarily to low levels of dissolved oxygen, though ammonia was a contributing factor. Algal blooms supplied oxygen during hours of high light intensity but created additional oxygen demands at night and when the sky was overcast.

1970-1084
SEELEY, Margaret S.
Federal Solid Waste Disposal Assistance Available to Local Governments
Proc. Conf. Agr. Waste in an Urban Environment. p. 160-170

This paper contains a listing of then-current federal solid waste disposal assistance available to local governments through HEW, interior, Agriculture, HUD, Commerce, and the Council on Environmental Quality. Pending solid waste legislation is reviewed and cases are cited, mostly for municipal wastes, of recent activities.

1970-1085
SHEPPARD, C. C. [Editor]
Poultry Pollution: Problems and Solutions
Mich. State Univ. Ag. Ex. Sta. Rsch. Rpt. 117. 55 p.

This report contains nine papers abstracted separately [DAVIDSON and MACKSON, 1970-1016; FLEGAL, GOAN and ZINDEL, 1970-1021; FLEGAL and ZINDEL, 1970-1022, 1023, 1024; ROBERTSON and WOLFORD, 1970-1081; SURBROOK, BOYD, and ZINDEL, 1970-1092; THOMAS, 1970-1096; and YORK, FLEGAL, ZINDEL and COLEMAN, 1970-1110] plus an introduction by H. C. ZINDEL and C. J. FLEGAL (p. 4-7), "Bacteriological Procedures" by H. C. ZINDEL (p. 45-46), summaries of research on dried poultry waste in progress (p. 47-48), and a compilation of all samples of poultry waste analyzed by Dr. E. J. BENNE (p. 49-55).

The research in progress includes the following projects:

H. BUCHOLTZ: The replacement of standard protein sources in beef cattle rations with DPW,

C. J. FLEGAL: Are drugs fed poultry present in DPW?,

C. J. FLEGAL: How does the length of storage time affect the protein content of DPW?

C. C. SHEPPARD: Does the temperature of drying affect the protein content of DPW; and

C. C. SHEPPARD: Drying chicken manure under laying cages on electrically heated panels.

1970-1086
SMITH, L. W.; GOERING, H. K.; and GORDON, C. H.
In Vitro Digestibility of Chemically-Treated Feces
Jnl. Animal Sci. 31: 1205-1209
Abst: McO & B B-233

Despite the effective capacity which ruminants have for digesting the cellulose and hemicellulose of plant walls, some 40 and 60 percent of this potential energy source escapes digestion and appears in the feces. Laboratory studies have demonstrated that some chemical treatments are effective in enhancing the digestibility of these residues. "Sodium hydroxide is by far the most economical for treatment of fecal cell walls even if the hydrolysed fraction of the cell wall is not recovered or utilized in fermentation. Separation of the soluble fecal dry matter from cell walls prior to treatment with sodium hydroxide is not necessary to obtain significant responses."

1970-1087
SOBEL, A. T.
Block Drying of Chicken Manure
Compost Sci. 9: May-June p. 28-29

Chicken manure can be formed into blocks which will air dry and store with a minimum odor. Final weight can be 29 percent of the original, and the final volume half the original. Viable organisms are decreased substantially but not eliminated. Nitrogen is lost in drying and storage.

1970-1088
SORG, Thomas J.
Industrial and Agricultural Solid Wastes and Problems Involved in Their Disposal
Public Health News (New Jersey) Mar. p. 67-69

"Animal manure is being composted, dried, and pelletized for soil conditioners, animal feed supplement, and fertilizer base." Reprocessing will play a major role in solving waste disposal problems.

1970-1089
STAHL, George R.
Identifying Agricultural Waste Problems: Dairy
Penn. Conf. on Agr. Waste Mgmt. p. 44-46

This is a general treatment of the problem of waste disposal in the dairy industry.

1970-1090
STEEN, Chester A.
The Public Relations of Agricultural Waste Management
Proc. Conf. Agr. Waste in an Urban Environment p. 174-182

A dairy having purchased a dehydrator for alfalfa hay used it for drying manure rather than letting it stand idle much of the time. Sale of the dried manure has produced substantial income.

Composting should be perfected. It holds real promise for both agricultural and municipal waste.

Refeeding, after satisfying health authorities and gaining public acceptance, will aid in both food production and pollution abatement.

1970-1091
STEWART, B. A.
Volatilization and Nitrification of Nitrogen from Urine Under Simulated Cattle Feedlot Conditions
Environ. Sci. and Tech. 4: 579-582
Abst: McQ & B B-110

"When urine was added every 2 days to an initially wet soil at the rate of 5 ml per 21 cm^2, less than 25 percent of the added N was lost as ammonia and 65 percent was converted to nitrate. When urine was added every 4 days to initially dry soil, essentially all the water evaporated between urine additions, and 90 percent of the added N was lost as ammonia. These findings suggest that the stocking rate and other management factors should be considered in pollution abatement."

1970-1092
SURBROOK, T. C.; BOYD, J. S.; and ZINDEL, Howard C.
Drying Animal Waste
Mich. State Univ. Ag. Ex. Sta. Rsch. Rpt. 117 p. 16-20
Abst: McQ & B E-195; W71-03559

Tests of a commercially-produced on-the-farm dryer for manure are reported. The machine successfully processed dairy, beef, swine, and poultry excreta including small amounts of straw and wood-chip litter.

Operating temperatures ranged from 200 to 1100°F. Some odor resulted. Efficiencies and costs per ton for 40-hr and 80-hr per wk operation were

Poultry	71.8% ,	$36.69 , and	$27.53
Bovine with 2% straw	51.6	63.65	47.08
Swine	44.1	56.70	42.54

1970-1093
TELLER, Chester J.
Farms Are Not Out in the Country Any More
Compost Sci. 11: Jan-Feb. p. 8-9

To retain agricultural production engulfed by environment-conscious suburbia, New Jersey is studying plow-furrow-cover disposal, composting, and the possibility of using fungi to convert carbohydrate wastes into protein supplements.

1970-1094
TEOTIA, J. S. and MILLER, Byron F.
Factors Influencing Catabolism of Poultry Manure with *Musa Domestica* (Abst)
Poultry Sci. 49: 1443
Abst: McQ & B B-290

Optimum conditions for fly larvae are 25°C and 38 percent relative humidity. They will abandon manure if the moisture content reaches 80 percent. Fungal development occurs at 37°C and 70 percent relative humidity. Pupae develop well under caged layers; they will reduce fresh manure to a granulated product in a few hours.

1970-1095
TEOTIA, J. S. and MILLER, Byron F.
Nutritional Value of Fly Pupae and Digested Manure (Abst)
Poultry Sci. 49: 1443
Abst: McQ & B B-291

It was determined that fly pupae have potential as a protein supplement in chick starter and broiler diets.

1970-1096
THOMAS, J. W.
Acceptability and Digestibility of Poultry and Dairy Wastes by Sheep
Mich. State Univ. Ag. Ex. Sta. Rsch. Rpt. 117. p. 42-44
Abst: McQ & B E-200; W71-03564

Equi-protein rations, 11 percent dry basis, of which about 45 percent was from feces or soybean meal, were prepared from a base of ground corn, ground corn cobs, molasses, vitamins and minerals. To this 31.9 percent dried poultry waste, 39.0 percent dried dairy waste, or 11.2 percent soybean meal was added. Sheep and dairy heifers accepted all rations readily. Total digestive nutrient value was 56 percent for dairy wastes, 55.9 percent for DPW, and 63.4 percent for soybean rations. Other data are tabulated.

1970-1097
THOMAS, J. W.; YU, Yu; and HOFFER, J. A.
Digestibility of Paper and Dehydrated Feces (Abst)
Jnl. Animal Sci. 31: 255-256

Heifers fed paper, feces from dairy cattle without bedding, dried poultry wastes, and soybean rations accepted 10 to 50 percent feces readily, but objected to paper even when soaked in molasses and water and mixed with corn silage. Dry matter digestibilities were paper 62 percent, cattle feces 29 percent, poultry waste 39 percent, and soybean ration 64 percent.

1970-1098
TOWNSHEND, A. R.; BLACK, S. A.; and JANSE, J. F.
Beef Feedlot Operations in Ontario
WPCF Jnl. 42: 195-208
Abst: McQ & B B-081; W70-07045

For conditions in Ontario where most feedlots contain 300 head or less and where rapid growth is not anticipated, land disposal is expected to remain the preferred method of handling animal wastes. Mechanical aeration is considered to be an effective means of controlling odor. "Other methods of farm waste disposal have been suggested including: (a) composting with or without municipal garbage; (b) incineration; (c) disposal in sanitary landfills; (d) liquid waste treatment systems; and (e) reuse as animal feed. . .limited technology and present agricultural economics rule out all of these methods for Ontario use in the foreseeable future. . ."

1970-1099
TUCKER, E. W.
Animal Waste and Environmental Quality
Proc. Conf. Agr. Waste in an Urban Environment. p. 196-203

Manure destined for land spreading must be stored -- often for months. All methods of treatment are expensive and/or produce objectionable odors. Risk of water pollution is omnipresent.

The speaker, President of the American Veterinary Medical Association, pleads for a sound program, good communications, and cooperation.

1970-1100
VANDERHOLM, Dale H. and BEER, Craig E.
Use of Soil to Treat Anaerobic Lagoon Effluent: Design and Operation of a Field Disposal System
ASAE Trans. 13: 562-564 [ASAE Paper 69-459]
Abst: McQ & B B-042, G-058; W71-06806

Effluents from an anaerobic lagoon treating animal wastes are high in solids and nutrients. Land irrigated with them should be well drained. It would usually be well to dilute the effluents as well. A portable irrigation system has desirable cost and flexibility characteristics. The land requirement varies with soil type and climate.

1970-1101
VENNES, John W.
State of the Art -- Oxidation Ponds
2nd Intl. Symp. for Waste Trtmt. Lagoons p. 366-376

This well-documented survey is concerned primarily with sewage oxidation ponds. The basic biochemical reactions are discussed and the questions of bacterial and viral survival and insect breeding are emphasized.

1970-1102
WELLS, Dan M.; GRUB, Walter; ALBIN, Robert C.; MEENAGHAN, George F.; and COLEMAN, Eugene
Control of Water Pollution from Southwestern Cattle Feedlots
Proc. 5th Intl. Water Pollution Rsch. Conf. Paper II-38. 19 p.
Abst: W71-05412

Groundwater from a shallow aquifer constitutes the principal water supply for the High Plains of West Texas. To protect the aquifer from possible contamination from feedlot runoff, laboratory and field tests were conducted to determine the characteristics of the liquid and solid portions of the wastes and of the runoff resulting from precipitation on feedlots. Agronomic studies explored the feasibility of employing the runoff for crop irrigation.

The study concluded that quality of runoff is not materially affected by ration fed or by quantity of precipitation, that treatment of runoff by conventional methods is not feasible, that direct application of undiluted runoff to crops is detrimental, that storage in unlined ponds risks groundwater pollution, and that liquid handling systems for cattle feedlot wastes are thus not feasible.

1970-1103
WEST, Arthur H.
Agricultural Waste Legislation
Proc. Conf. Agr. Waste in an Urban Environment. p. 221-222

Legislation directed toward land-use planning is highly desirable. Reponse to hysteria must be cautious.

1970-1104
WHEATLAND, A. B. and BORNE, B. J.
Treatment, Use, and Disposal of Wastes from Modern Agriculture
Water Poll. Control 69: 195-208
Abst: McQ & B A-306, A-543; W70-08334

Recent experimental work in the UK has included odor control during storage and spreading of piggery slurry by minimal mechanical aeration, and the flushing of confinement sheds with supernatant liquid from the retaining tank. Possible future methods include incineration. For this to be economical drying to a moisture content under 70 percent is required. The possibility of accomplishing this by filtration is being investigated. Laboratory results of wet oxidation investigations are tabulated. Disposal at sea by means of an eight-mile long outfall or by barges is suggested.

1970-1105
WHITE, Colin
Broiler Litter on Welsh Coal Tips
Agriculture 77: 49-51
Abst: McQ & B E-019

Coal tips and opencast mines are nearly sterile. Some 2.25 million tons of poultry manure are produced in the UK per year, much of which has no convenient disposal site despite its fertilizer value. Litter is preferable to manure in that seeds germinate well in the former and poorly in the latter.

1970-1106
WHITE, James E.
Current Design Criteria for Anaerobic Lagoons
2nd Intl. Symp. for Waste Trtmt. Lagoons. p. 360-363
Abst: McQ & B A-241

No published state requirements have appeared. The BOD, suspended solids, detention times, and expected percentage reductions are tabulated for the nine states answering a questionnaire. Descriptions in the literature often give incomplete data and use a variety of parameters.

Lagoon performance is affected by organic loading, temperature of contents, depth, and amount of recirculation. There is little advantage to using anaerobic lagoons in series. The effluent is not fit for discharge to streams.

1970-1107
WIDNALL, William B.
Agricultural Waste Legislation
Proc. Conf. Agr. Waste in an Urban Environment. p. 144-152

Laws presently on the books which are expected to aid in solving the problems of agricultural waste utilization or disposal include those governing water pollution and solid waste management. In addition, many statutes governing the activities of the USDA include such provisions.

1970-1108
YEATMAN, James
Identifying Agricultural Waste Problems: Mushroom
Penn. Conf. on Agr. Waste Mgmt. p. 41-43

Pennsylvania alone uses 250,000-300,000 tons of solid waste per year as a basic material for compost. This consists of horse manure, mulch hay and corncobs. Some poultry litter is also added. For a crop of about 125 million pounds, the spent compost to be replaced weighs about 400,000 tons. This compost can be processed to produce organic fertilizer. If spread on land in a 12-16 in. thick bed and tilled for three years, it becomes excellent marketable top soil.

1970-1109
YECK, Robert G.
Animal Waste Management Research
Midwestern Animal Waste Mgmt. Conf., Des Moines. 7 p. proc.

Included in this overview of current research on animal waste management are a) a brief historical review of the changing problems, b) an orientation on some of the systems of research classification in use, c) an indication of the personnel involved in the research, and d) a discussion of the current status of research.

1970-1110
YORK, L. R.; FLEGAL, Cal J.; ZINDEL, Howard C.; and COLEMAN, T. H.
Effects of Diets Containing Dehydrated Poultry Waste on Quality Changes in Shell Eggs During Storage
Poultry Sci. 49: 590-591
Reprint: Mich. State Univ. Ag. Ex. Sta. Rsch. Rpt. 117: p. 39-41
Abst: McQ & B B-285, E-199; W71-00930

"At the end of any given storage period, color and odor observations revealed no differences among the eggs from birds on different dietary treatments. All were acceptable and 'normal'." The diets in question contained 0, 10, 20, and 30 percent DPW.

1970-1111
SYMPOSIUM
Second International Symposium for Waste Treatment Lagoons
Kansas City, Mo., 23-25 June. 404 p.

The majority of the papers presented were pertinent primarily to the treatment of municipal wastewaters. Six bearing on the application of lagoons to the management of animal wastes are abstracted separately. These are:

DORNBUSH, James N. - State of the Art -- Anaerobic Lagoons. p. 382-387 [1970-1018],

HART, Samuel A. - Animal Manure Lagoons, A Questionable Treatment System. p. 320-326 [1970-1032],

LOEHR, Raymond C. and SCHULTE, Dennis D. - Aerated Lagoon Treatment of Long Island Duck Wastes. p. 249-258 [1970-1053],

PFEFFER, John T. - Anaerobic Lagoons -- Theoretical Considerations. p. 310-320 [1970-1076],

VENNES, John W. - State of the Art -- Oxidation Ponds. p. 366-376 [1970-1101], and

WHITE, James E. - Current Design Criteria for Anaerobic Lagoons. p. 360-363 [1970-1106].

1970-1112
SYMPOSIUM
Agricultural Waste in an Urban Environment. Atlantic City, 14-17 Sept.
Proc. 256 p.
Abst: W71-07552

Increased human populations and increased per capita consumption of meat have led to confinement feeding operations. Traditional land disposal is hampered by lack of land, nearness of neighbors, and necessity of preventing pollution of land, surface water, groundwater, and air.

Pertinent papers are abstracted separately.

1970-1113
SYMPOSIUM
Pennsylvania Conference on Agricultural Waste Management
Nov. 17-18, Harrisburg, Pa.

Animal waste papers abstracted separately are:

HERR, Glenn - Identifying Agricultural Waste Problems: Poultry. p. 35-38 [1970-1036],

KING, Thomas - Identifying Agricultural Waste Problems: Livestock. p. 39-40 [1970-1043],

LARSON, Russell E. - Searching for Solutions. p. 3-19 [1970-1048],

PORTER, Gilbert H. - Agricultural Waste Research Goals and Needs. p. 69-73 [1970-1077],

STAHL, George R. - Identifying Agricultural Waste Problems: Dairy. p. 44-46 [1970-1089], and

YEATMAN, James - Identifying Agricultural Waste Problems: Mushroom. p. 41-43 [1970-1108].

1970-1114
ANON
To House 20,000 Head of Cattle
Agr. Engrg. 51: 516-517
Abst: McQ & B B-643

The world's largest covered cattle feeding lot has been opened at South Charleston, Ohio. Many innovations are described. "A front-end loading tractor picks up the manure for transfer to an anaerobic digester. The raw manure is sterilized there in a six-day process, then sold as weed- and pathogen-free organic fertilizer."

1970-1115
ANON [Based on J. Ronald MINER]
ISU Engineer Warns Feeders Oxidation Ditch Isn't Magic
Beef 6: Oct. p. 10

An oxidation ditch controls odors and keeps manure liquid. It should be used in conjunction with a lagoon from which water needed for makeup can be returned to the ditch and excess water can be used to irrigate cropland. None of the effluent will be fit to release to streams.

1970-1116
ANON [Based on Earl D. MOBLEY]
Liquid Manure Systems Have High Per Head Cost
Beef 6: Nov. p. 41

Cost figures are quoted for an oxidation ditch ($39.91 yearly capital cost and $9.29 yearly operating cost), slatted floor and scraper system ($22.45 capital, operating costs not presently available), and an open lot system ($8.88 capital and $2.95 operating) in Iowa. The lots are described and pictured in BEEF 6: Oct. p. 54-55. Costs do not include lagoons and irrigation systems. They are also subject to scale effects.

1970-1117
ANON [Based on Gene ERWIN]
Pollution May Be a Blessing to Cattle Feeders
CALF News 8: June p. 14

Wastes from many industries are having their potential for conversion to cattle feed studied intensively. "It is entirely feasible that even a small feeder will be able to process manure on his lot for conversion into a low-cost nutritious feed."

1970-1118
ANON
Texas Legislature Views Feedlot Pollution
CALF News 8: Oct. p. 52-53

At a hearing in Amarillo a committee of the Texas Legislature explored possible feedlot legislation. Kansas law was reported to require that feedlots have land available for runoff disposal in an amount which is a function of annual precipitation and contributing drainage area. Solid waste disposal is limited to 20-30 tons/acre-yr, with none permitted on land used for liquid disposal.

1970-1119
ANON
Some Call It . . . Manure
CALF News 8: Nov. p. 40-41

Feedlots of more than about 8000-head capacity often have a virtually insolvable manure problem. Land for spreading may not be available. Piled, it constitutes a health problem and threatens to pollute surface and ground water. Treatment paralleling sewage treatment is impractical. Use of processed manure for refeeding has been pioneered in the poultry industry; it deserves careful research for beef. "Probably the most promising avenue will be the use of feedlot manure as a fuel to generate the power to run the feedlot." Odors can be eliminated in the processing and, if no earth is scraped up with the manure, the ash residue "can be used as a building material." The industry should sponsor research to perfect the techniques.

1970-1120
ANON [Based on Richard G. REESE]
Imagine Your Feedlot Manure Can Power Your Mills and Bring Cash From Sale of Excess Power!
CALF News 8: Nov. p. 42, 45

A 400-ton-a-day combustion power unit for solid waste incineration for cities is now being developed. A model to handle 40 tons per day, ideal for large feedlots, would generate 1000 KW, produce "waste" heat at 950°F, and produce a small amount of ash with value as a fertilizer or feed ingredient for potassium and phosphates. Cost at present would be a quarter million dollars.

1970-1121
ANON [Based on Del WILLIAMSON]
GE Also Working on Solid-Waste-to-Electricity Converter
CALF News 8: Nov. p. 43

General Electric is working on a water-wall boiler and on a vortex-type incinerator. "GE is one of three companies we know of working on the converting of waste into electrical power. We understand there are others."

1970-1122
ANON [Based on Jim CLAWSON]
The Economics of Feedlot Manure
CALF News 8: Nov. p. 43-44

"The cost of converting manure to fertilizer frequently exceeds the value of increased crop response." Costs for mechanical loading and delivery within 15 miles are stated to be $1.40 per cu yd without stockpiling or $1.70 with.

1970-1123
ANON [Based on Jay SMITH]
Nature's Own Manure Treatment System
CALF News 8: Nov. p. 56

Studies of soil cores under feedlots have shown high concentrations of nitrates in upper layers. "It also shows a great increase in bacteria underneath feedlots, and these are most beneficial in the denitrification process."

1970-1124
ANON [Based on Gedalyahu SHELEF]
Process Treats Waste Water, Produces Algae
Chem. and Engrg. News 48: 3 Aug. p. 47

A pilot plant operated on the Advanced Photosynthetic System (APS) at Hebrew University, Jerusalem, treats waste water, renovates it for recycling, and produces protein in the form of algae. Filtration is employed in the pilot plant, but lime flocculation, with recovery of the lime, is the anticipated method for a prototype plant. Removal of 90 percent of the BOD and COD, 80 percent of the total nitrogen, and 50 percent of the dissolved phosphorus is reported.

1970-1125
ANON
New Uses for Poultry Manure?
Compost Sci. 9: July-Aug. p. 19 Disc: Nov-Dec. p. 30

Dried poultry manure provides sustained soil improvement. In Britain it is being used as animal feed and for the reclamation of strip-mined areas.

In the discussion E. L. STEPHENSON lists U. S. and Canadian studies on refeeding with several references to publications of the University of Arkansas and others.

1970-1126
ANON
The Disposal of Intractable Industrial and Agricultural Wastes
Effluent and Water Trtmt. Jnl. 10: 72-73, 75, 77, 80-82, 147, 150, 151

In a list of 13 types of wastes, animal manure slurries are considered to have no normal feasible method of pre-treatment other than simple ground disposal of waste as collected. Treatments, recoveries, or disposals at disposal site include "pass through spray-drying plant to give dry granular fertilizer, or thicken and incinerate."

1970-1127
ANON
Agriculture Is Industry
Effluent and Water Trtmt. Jnl. 10: 570, 572

". . . large units will find access to suitable land increasingly difficult for this direct means of disposal. Full biological treatment is too expensive and local authority charges (where indeed, sewers existed) would be prohibitive."

"On the face of it there seem to be limited solutions, including, however, drying the material for economic transportation well away from the area of production."

1970-1128
ANON [Based on H. T. BARR et al]
Lagoons for Poultry Houses
Poultry Digest 29: 28

Five flocks of layers were raised at Louisiana State over a lagoon without changing the water. Feathers and floating manure were broken up from time to time by a high velocity jet of water. The lagoon effluent was discharged into an open ditch 1500 ft from a fish-populated bayou. The fish were not harmed. Hen performance was good.

1970-1129
ANON [Credited to Australasian Poultry World]
Preserving Fertilizer Value of Manure
Poultry Digest 29: 86

To preserve nitrogen in stored manure, dry it quickly or dress the droppings once a week with superphosphate. Avoid wetting of deep litter by runoff, seepage or spillage of water. Hot air ventilation promotes drying.

1970-1130
ANON [Credited to S.A.P.A. Poultry Bull., So. Afr., Nov. 1969]
Poultry Manure as Ruminant Feed Ingredient
Poultry Digest 29: 90

". . . poultry manure is being processed, packaged and sold commercially as a ruminant feed in England. Its analysis is approximately: crude protein equivalent, 26.6%; ash, 15.24%; carbohydrates, 38.7%, and moisture, 7.68%." Performance of animals on DPW "was in no way inferior to that of the conventionally fed controls, and since the manure containing rations were much less expensive, profitability was higher."

1970-1131
ANON [Based on W. R. JENKINS. Credited to Australasian Poultry
World. Sept. 1969]
Six Ways to Handle Disposal of Manure
Poultry Digest 29: 133

Six methods, each with advantages and disadvantages, are: spreading, dehydrating, incineration, lagoons, sanitary land filling, and composting. Feeding broiler litter to beef cattle is also mentioned.

1970-1132
ANON
Algae Diet Darkens Yolks
Calif. Farmer
Reprint: Poultry Digest 29: 134-135

Green algae is about fifty percent protein. Used as a food supplement for chickens, it produces a deep yellow color in the egg yolks, but has no apparent effect on egg production, weight, or size. It may be used as ten percent of the ration. Some natural algae are toxic, but controlled algae growths on a treatment pond are of interest in that they would provide feed and aid in pollution control simultaneously.

1970-1133
ANON [Credited to U. C. Dateline, Davis. Feb. 1970]
Where to With Manure?
Poultry Digest 29: 179

As land spreading becomes less feasible, methods such as pyrolysis, use of liquid manure to raise algae to be grazed by fish, and treatment to alter manure to be less polluting and/or better fertilizer need intensive research.

1970-1134
ANON [Based on Herbert C. JORDAN]
Needs for Marketable Poultry Manure
Poultry Digest 29: 181

To be salable 1) poultry manure must be dried to below twenty percent moisture content, 2) total microbe count must be reduced drastically, 3) only aerobic bacteria can be tolerated, 4) odor must be removed then masked, 5) nitrogen must be fixed to prevent burning plants, 6) N, P, and K should be retained in original amounts, 7) chemical and biological additives must be controlled, 8) the product must flow through a lawn spreader, 9) the product must store well, and 10) "Manure" should not appear in the advertising.

1970-1135
ANON [Based on C. B. FAIRBAIRN. Credited to Poultry World, 9 Apr.]
Dried Poultry Manure as Cattle Feed
Poultry Digest 29: 331

". . . dried poultry waste has a protein value similar to cereals and an energy content about one-third that of grain. However, trials. . . have shown it to be suitable and economically viable for inclusion in intensive beef rations." Concern with possible disease transmission remains.

1970-1136
ANON [Based on Byron F. MILLER. Credited to Colo. State Univ. Rsch. Apr-June 1970]
Fly Pupae High Quality Protein Supplement
Poultry Digest 29: 385

Breeding colonies for pathogen-free houseflies were established. Eggs were collected and used to inoculate fresh poultry manure. The eggs hatch in five or six days and the larvae remove about 80 percent of the organic content and reduce the moisture content of the manure. The larvae and pupae are collected and processed into a high quality protein supplement. The economics appear favorable.

1970-1137
ANON
Connecticut Requirements for Liquid Manure Disposal
Poultry Digest 29: 583

The Connecticut Public Health Department requires that liquified manure be spread only on relatively level fields at a distance greater than 200 ft from any water course or water surface. It may not be spread on snow, frozen ground or saturated ground. Several fields of pasture land should be available to permit rotation. Applications of liquid manure should be limited to 5000 gal.

1970-1138
ANON
Animal Waste Treatment Research
Pub. Wks. 101: Feb. p. 128

Cornell University is to inaugurate a new Animal Waste research laboratory in the Spring of 1970. Pending projects are listed.

1970-1139
ANON
Coming: Pollution Control for Your Lot?
Western Livestock Jnl. 48: Apr. p. 56-58

Regulations are being considered by many states. The characteristics of a workable code are discussed. Latitude should be left for adoption of better methods as they are developed.

1970-1140
ANON [Based on George PRATT and R. L. WITZ]
Scientists Tackle Manure Disposal
Western Livestock Jnl. 48: Oct. p. 95

Cattle production has been declining in North Dakota. Confined beef feeding appeared to be an answer but is only partially successful. Oxidation ditches leave ultimate disposal problems. Manure storage within the buildings produces gases and humidity. Dehydration for fertilizer and/or refeeding is being considered. The fuel value of manure is 6300 Btu/lb; lignite's is 6900, and wood has values ranging from 8300 to 9200.

1971-1001
ADAMS, Richard L.
The Dry Deep Pit System
Poultry Tribune 77: Apr. p. 26, 28

Odors, flies, and nutrients in water courses are the typical pollution problems associated with poultry. All can be eliminated by use of a deep (8 to 10 ft) pit under the poultry house if it is kept dry. Install and maintain a proper watering system. Mechanical ventilation will be required for high-density chicken populations. The pit may never require cleaning.

1971-1002
ADOLPH, Robert H.
Drying Manure Under Cages
Poultry Digest 30: 389

Drying depends on rate of air movement, amount of moisture in the air and to be removed, and air temperature. To aid in drying, open chicken houses in warm weather, increase the exposure of droppings, and retain a dry pad of manure after cleanout.

1971-1003
ADOLPH, Robert H.
A Program of Manure Management to Control Fly Breeding in a Semi-Arid Climate (Abst)
Poultry Sci. 50: 1544
Abst: McQ & B B-299

Methods of controlling fly breeding in chicken manure include providing a dry pad of manure coned to catch fresh manure, avoiding cleanout during fly breeding season, avoiding water spillage on manure, and maintaining adequate air movement.

1971-1004
ADRIANO, D. C.; PRATT, P. F.; and BISHOP, S. E.
Fate of Inorganic Forms of N and Salt from Land-disposed Manure from Dairies

Proc. ISLW p. 243-246
Abst: McQ & B C-281

Continuous disposal of cattle wastes, without pretreatment, on irrigated croplands and pastures of Southern California, has built up concentrations of salt and NO_3^- in the soil. The Chino-Corona Basin between Riverside and Los Angeles carries 122,000 dairy cows in 40 sq mi. The manure load is about ten cows per acre whereas equilibrium can be maintained only below about three cows per acre. A partial solution would be to volatilize the ammonia before incorporating the manure into the soil.

1971-1005
ALAMPI, Phillip
Introduction [Keynote to Conference]
Proc. Natl. Symp. on Animal Waste Mgmt. p. 3-5

For highly urbanized areas such as New Jersey, of which ALAMPI is Secretary of Agriculture, reuse of manure as animal and poultry feed must be instituted. Technology such as dehydration and bacterial fermentation exists. The Food and Drug Administration should grant approval and permit areas with high land, labor, and grain costs to employ this procedure.

1971-1006
ALBIN, Robert C.
Handling and Disposal of Cattle Feedlot Waste
Jnl. Animal Sci. 32: 803-810
Abst: McQ & B B-235

In this richly-documented review of the subject, methods currently in use are described and evaluated. For the future it can be anticipated that concern for environmental pollution will intensify. Research needs are for further investigation of means to eliminate air, water, and land pollution economically, subject to more stringent socio-legal restraints.

1971-1007
ALBIN, Robert C.; WINSTEAD, J.; ZINN, D.; WELLS, Dan M.; GRUB, Walter; COLEMAN, Eugene; and MEENAGHAN, George F.
Cattle Performance in Southwestern Feedlots (Abst)
Jnl. Animal Sci. 33: 206-207

Cattle fed an all-concentrate ration produced 1.05 kg waste per day, while those fed a ration with 10-12 percent roughage produced 2.77 kg. Efficiency was better on all-concentrate; daily gain was better with the roughage.

1971-1008
ALEXANDER, Edward L.
Soil Conservation Service Standard and Specifications for Pollution
Abatement Measures for Confined Livestock or Poultry Feeding
Operations
Soil Conservation Service -- Texas Tech Workshop. Lubbock. 28-29 July.
10 p.

Soil Conservation Service design criteria involve the compliance with Texas Water Quality Board regulations including the by-passing of inflow, the trapping of outflow, and the ability to dewater the retention pond without releasing water to streams or draws. Site selection for feedlot, detention ponds and spreading fields is of basic importance. Standard designs of hydraulic structures should be used subject to a few modifications which are discussed in some detail.

Lagoons are usually not appropriate with open feedlots. Provision for irrigation tailwater recovery may be necessary.

1971-1009
ANDERSON, John R.
Succession and Ecology of Diptera in Cattle Droppings
EPA Pbln. 5r.2, p. 52-54

Cowpats in pastures in California have provided lodging places for at least 50 species of flies and 35 species of beetles. Of these, only the horn fly and the face fly are pests; the others speed the recycling of the feces. In a feedlot only seven species of flies survive. These include the house fly and the stable fly.

1971-1010
ANDRE, Paul D.
$170 Per Head -- But It Pays!
Beef 7: June p. 24-25

Gypsy Hill Farms in Southern Illinois feeds cattle on open lots ($20 per head), in a three-wall confinement barn with sawdust and straw on dirt ($35), and in a similar structure with slatted floors and an oxidation ditch ($170 as installed, but $125 estimated if redone with present knowledge). Summer performance is about the same for the three installations. The open lot and the dirt-floor barn have similar winter performance, affected by mud.

Drainage from the oxidation ditch is to an anaerobic lagoon 26 ft deep, 100 ft in diameter. Overflow is to a one-acre aerobic lagoon 34 inches deep.

The owner plans to convert the dirt-floor barn by installing another oxidation ditch.

1971-1011
ANDRE, Paul D.
70¢ A Head Pollution Control
Beef 8: Nov. p. 5-6

For a 400-head lot $280 out-of-pocket plus an $820-grant from the Agricultural Conservation Program provided a debris basin with a screened central drain to a holding pond. Excess water, if any, from the holding pond can be pumped for irrigation.

1971-1012
ANDREWS, John F. and KAMBHU, Kawi
Thermophilic Aerobic Digestion of Organic Solid Wastes
Environmental Systems Engrg. Dept., Clemson Univ. 76 p.

This is a theoretical analysis of the steady-state operation of thermophilic anaerobic digestion of organic wastes; the authors suggest its application to the sludge resulting from the treatment of sewage containing ground garbage. The process can be self-sustaining from an energy standpoint with an adequate supply of air or, preferably, pure oxygen. The advantages cited for the process are 1) increased reaction rates for the destruction of organic solids, 2) increased efficiency with respect to the fraction of organic solids destroyed, 3) increased destruction of pathogenic microorganisms, and 4) improved solids-liquid separation. Fifty-five references are cited.

1971-1013
ANTHONY, W. Brady
Animal Waste Value -- Nutrient Recovery and Utilization
Jnl. Animal Sci. 32: 799-802
Abst: McQ & B B-234

In this very well documented paper, ANTHONY cites many successes in the feeding of poultry, swine, and cattle wastes to animals as a means of utilizing nutritive values, particularly nitrogen and minerals. ". . . Ill-founded legal regulation and the serious threat of adverse public opinion are presently the primary factors preventing development of realistic plans to recycle animal waste."

1971-1014
ANTHONY, W. Brady
Cattle Manure as Feed for Cattle
Proc. ISLW. p. 293-296
Abst: McQ & B C-296

ANTHONY reviews the literature (ten references) and reports on the three most recent in a long series of tests of incorporating wastelage (a fermented mixture of manure and hay) in cattle rations at Auburn University.

"It is not feasible to return all the manure to the steer from which it is collected, but a brood cow is an excellent feed consuming unit to combine with a steer in this program." A flow sheet gives quantities involved. "Wastelage and corn combined in the ratio of 1:1.5 constitutes a satisfactory ration for finishing slaughter animals. . . The surplus wastelage can be used as the complete ration for beef brood cows."

1971-1015
APPELL, Herbert R.; FU, Y. C.; FRIEDMAN, Sam; YAVORSKY, P. M.; and
WENDER, Irving
Converting Organic Wastes to Oil
USDI Bur. of Mines Rpt. of Investigations 7560. 20 p.
Abst: McQ & B E-133

"The Bureau of Mines is experimentally converting cellulose, the chief constituent of organic solid waste, to a low-sulfur oil. All types of cellulosic wastes, including urban refuse, agricultural wastes, sewage sludge, wood, lignin, and bovine manure have been converted to oil by reaction with carbon monoxide and water at temperatures of 350° to 400°C and pressures near 4000 psig, and in the presence of various catalysts and solvents. Cellulose conversions of 90 percent and better (corresponding to oil yields of 40 to 50 percent) have been obtained."

Experimental procedures are described and the effects of varying temperature, pressure, and water content, and of using various solvents and catalysts are discussed. Continuous, rather than batch, operation has been limited to solutions of sucrose to date. Concurrently special slurry feed pumps are being tested.

It is concluded that "a significant part of the energy demand of the Nation can be obtained on a renewable basis by converting nearly every kind of organic solid waste to a low-sulfur oil by treatment under pressure with carbon monoxide and water. Methods for lowering carbon monoxide consumption and for operating at lower pressures have been found; these offer the potential of low processing costs for converting cellulosic wastes to oil."

1971-1016
ARIAIL, J. D.; HUMENIK, F. J.; and KRIZ, G. J.
BOD Analysis of Swine Waste as Affected by Feed Additives
Proc. ISLW. p. 180-182, 189
Abst: McQ & B C-262

BOD test results are subject to interferences. Feed antibiotics, metals, and cold temperatures have been suspect. In a series of tests on swine manure at North Carolina State, copper was found to be the principal source of error. For a reliable BOD test, it is recommended that the material tested be diluted to a copper combination below 0.01 mg per 1.

1971-1017
BADGER, Daniel D. and CROSS, George R.
Economic Implications of Environmental Quality Legislation for Confined Animal Feeding Operations
Proc. ISLW. p. 204-206
Abst: McQ & B C-270

Based essentially on Oklahoma law and hydrologic regimes, the authors examine the current and anticipated requirements for waste disposal from confined operations and estimate costs. "Preliminary data indicate that no one system is superior to others. Types of animal wastes, labor availability, site location, capital availability and availability of land for disposal, affect the choice of pollution control practice adopted." Use of solid wastes on cropland, considering both costs and returns, is feasible.

1971-1018
BARRETT, F.
Farm Effluent -- Electrical Disposal Methods
Effluent and Water Trtmt. Jnl. 11: 207-209

A two-pond system is advocated in which "settled liquor is drawn from the deep section by a centrifugal pump and sprayed over the shallow section to aerate it with inspirated air. The overflow passes back over a weir into the deeper section." Effluent disposal is to some convenient point at least fifty yards from a watercourse.

Oxidation ditches are effective if properly maintained. A sludge containing barley husks and hair may block ditches used for pig manure. "One use of this material could be as a replacement for horse manure used by the mushroom industry, which is now in short supply."

Electrolytic floatation may aid in effluent treatment.

1971-1019
BARTH, C. L. and POLKOWSKI, L. B.
Identifying Odorous Components of Stored Dairy Manure
ASAE Paper 71-568 27 p.
Abst: McQ & B G-106

Following a literature review (27 references) on odors and their control, an account is given of laboratory methods used for their identification. "Selective absorptions, steam distillation and paper chromotography were the procedures used to identify four organic acids, ammonia, four amines and the sulfur-containing odorants -- hydrogen sulfide, disulfides, and mercaptans."

1971-1020
BARTH, Clyde L. and POLKOWSKI, Lawrence B.
Low-Volume, Surface-Layer Aeration -- Conditioned Manure Storage
Proc. ISLW. p. 279-282
Abst: McQ & B C-291

Long-term storage of manure is required in much of the dairy area of North America. Since waste should be returned to the soil before planting or after harvest, and not on snow, mud, or frozen ground, six months' storage capacity is commonly used. A manure storage lagoon is described in which the surface liquid layer is aerated to reduce odor and prevent scum formation. "The advantage of aerating only a surface layer is to reduce operation cost, improve nutrient recovery and allow reuse of supernatant in the waste handling system."

1971-1021
BARTLETT, H. D. and MARRIOTT, L. F.
Subsurface Disposal of Liquid Manure
Proc. ISLW. p. 258-260
Abst: McQ & B C-285

Penn State has developed and tested machinery for opening and raising the soil, depositing liquid manure in the void created, and restoring the displaced soil without turning it over. Field operations are described. The maximum amount of manure which can be safely spread on a continuing basis is that having a nitrogen content equal to the nitrogen utilizable by the crop. Tests with fifteen tons/year of dairy cattle manure resulted in nitrogen build-up in the soil.

1971-1022
BATES, D. W.
Handling Methods for Liquid Manure are Tested
Hoard's Dairyman 116: 273
Abst: McQ & B F-081

Tests in Minnesota established that "1) manure stored in a large tank (about 150,000 gallons usable capacity) can be agitated and removed without difficulty under proper management," 2) manure deposited in one end of the tank will distribute itself sufficiently by gravity, 3) emptying may be conducted in convenient stages, and 4) waste heat is valuable in preventing freezing.

1971-1023
BAYLEY, Ned D.
Animal Wastes and America the Beautiful
Proc. ISLW. p. 6-7
Abst: McQ & B C-214

Recycling of wastes into useful products is an ultimate aim. Progress toward it is cited. Land management, with allocation of land for meat and poultry production not subject to urban crowding, is highly desirable. "The priorities in research, as I see them, are methods of returning the wastes to the land, control of odors, and a systems approach to waste management."

Use of wastes for fertilizer; use of whey in animal feeds, foods and nutritious drinks; use of poultry blood and feathers for animal feed; and use of grease and other solid wastes from packing plants in animal feed are cited. Further research is required.

1971-1024
BELL, R. G.
Speeding Up a Natural Process Is One Way to Handle Wastes that Threaten to Overwhelm Us
AIC Review 26: Nov-Dec. p. 12-13

For composting, a mixture of garbage and manure has better qualities than either alone. Care must be exercised, however, to exclude tin cans, bottles, plastics, etc., and to limit salt content if the compost is to be spread on land. High-rate composting equipment is expensive, but windrowing is effective and cheap.

1971-1025
BELL, R. G.
Aeration of Liquid Poultry Manure: A Stabilization Process or an Odour Control Measure?
Poultry Sci. 50: 155-158
Abst: McQ & B B-294

Offensive odors of poultry manure are caused by the accumulation of by-products of anaerobic decomposition. It has been suggested that 0.1 percent fatty acid content is acceptable, but that 0.2 percent should be a minimum level for prosecutions under air pollution regulations. "Aeration as used in the experimental system must be considered as an odour control measure and not as a stabilization process."

1971-1026
BELL, R. G. and POS, Jack
Design and Operation of a Pilot Plant for Composting Poultry Manure
ASAE Trans. 14: 1020-1023 [ASAE Paper 70-419]
Abst: McQ & B B-059, G-080

Composting is most effective when the moisture content is near fifty percent, the carbon-to-nitrogen ratio is near thirty, and the texture is coarse, thus permitting aeration. Poultry manure, as removed from a chicken house, often has a moisture content above 75 percent, a carbon-to-nitrogen ratio of about ten, and it consists of fine particles. To be composted, it should be mixed with a dry carbonaceous substance. A composter was developed at Guelph and tested with indifferent success. Windrowing would have produced better compost, but would have released more ammonia.

1971-1027
BELL, R. G. and POS, Jack
Winter High Rate Composting of Broiler Manure
Canadian Agr. Engrg. 13: Dec. p. 60-64 [CSAE Paper 71-205]
Abst: McQ & B B-657, G-150

A high-rate composter consisting of a reinforced-concrete horizontal silo with an air distribution system incorporated into the floor was tested in Ontario in January. Freezing rain, sub-zero temperatures which required removal of frozen compost from the walls with chisels and crowbars and rodents which were "using the lower reaches of the composter as a 'centrally heated' home" caused difficulties. It was concluded, however, that 1) broiler manure can be composted outdoors in a Canadian winter without auxiliary heat, 2) a forced aeration system is essential for high-rate composting of broiler manure, 3) loading should be daily (seven days per week), 4) the composter should be roofed to avoid excessive wetting of the contents by rain, and 5) the addition of a blending material, preferably ground garbage, to raise the carbon-to-nitrogen ratio well above its value of 14.3 for broiler manure would be advantageous.

1971-1028
BERG, Norman et al
Solving the Problem: A Panel Discussion
Proc. Natl. Symp. on Animal Waste Mgmt. p. 57-66

BERG introduced a panel of five Kansans: Lloyd ESSICK, A farmer-rancher; Virgil D. BEOUGHER, District Conservationist; Bobby C. HEITSCHMIDT County Executive Director, ASCS; Virgil P. CARLSON, County Extension Agent; and L. Dean STROWIG, Area Engineer, Kansas Department of Animal Health. ESSICK, recognizing the pollution potential of an existing feedlot, had been assisted by the four other panel members in the design and financing of a relocated lot. Each discussed the input of his organization in the highly satisfactory venture.

1971-1029
BERGE, O. I.
Waste Handling: What Are the Choices?
Hoard's Dairyman 116: 353, 383
Abst: McQ & B F-082

The pros and cons of daily spreading, stockpiling for spreading when field conditions are more favorable, and liquid storage are stated. A tiny fraction of all dairy cow manure is dried and sold.

1971-1030
BERGE, O. I.
Waste Handling: What Does It Cost?
Hoard's Dairyman 116: 420
Abst: McQ & B F-083

Typical budgets are given and discussed for seven cases. Returning manure to the land for fertilization of feed crops is considered to be the best practice.

1971-1031
BERNARD, Harold; DENIT, Jeffery; and ANDERSON, Donald
Effluent Discharge Guidelines and Animal Waste Management Technology
Proc. Natl. Symp. on Animal Waste Mgmt. p. 69-83
Abst: McQ & B C-338

Runoff from a feedlot is intermittant (caused by rain or snow melt) and variable in quality. Its characteristics are such, however, that it is inadmissible in a watercourse. Lagoons are unlikely to be a lasting solution; their effluents are also unacceptable in streams. Water quality standards will require "zero discharge", by which is meant no direct runoff from feedlots or overflow from lagoons. While land spreading of manure and irrigation with effluent may introduce some pollution, it is considered to be manageable in a stream.

Acceptable methods of handling animal wastes include land spreading, use of oxidation ditches with land spreading of the effluent, barriered landscape water renovation systems [ERICKSON, et al, 1972-1043], composting, and "complete treatment." Waste recycling holds much promise for the future.

1971-1032
BERRY, Edward C.
Microbiological Stabilization of Animal Wastes
EPA Pbln. 5r.2 p. 27

The stabilization of measured quantities of animal excreta was observed under varied oxygen supply, pH, temperature, and amounts of water. Both aerobic and anaerobic microorganisms are necessary to reduce the BOD of animal wastes to acceptable levels.

1971-1033
BERRY, Joe G.
Composting Poultry Manure in Deep-Pits
Feedstuffs 43: 3 July p. 32

Deep pits in operation up to six years without odors, flies, or troubles are reported. The overriding consideration is that the manure must be kept dry. Sealing of the pit to protect groundwater and to exclude rodents is desirable. Labor and operating costs can be reduced significantly by use of deep pits. Building costs will be higher and serious trouble may occur if the manure gets wet.

1971-1034
BESLEY, Harry E.
Poultry Manure Disposal by Plow Furrow Cover
EPA Pbln. 5r.2, p. 27-29

The objectives of this research were "to develop equipment and techniques for disposing of poultry manure in soil by the plow-furrow-cover (PFC) method and to determine the amounts, frequency of application, and length of time that poultry manure may be so disposed of without undesirable effects." Experimental procedures are described and a warning is given of the high incidence of *Salmonella* in poultry manure (30 percent of the samples obtained for this study from commercial farms contained the pathogens).

1971-1035
BRESSLER, Glenn O.
Industry's Best Strategy for Waste Disposal
Poultry Tribune 77: Sept. p. 58, 60

Deep pits only postpone an inevitable stench-producing clean-out. Liquid handling has generally been unsatisfactory. Dehydrating by a two-stage operation -- 75 percent to 30 percent moisture by air drying while agitating the manure in the hen house, and 30 percent to 10 percent in a dryer later -- is economical.

1971-1036
BRESSLER, Glenn O. and BERGMAN, E. L.
Solving the Poultry Manure Problem Economically Through Dehydration
Proc. ISLW p. 81-84
Abst: McQ & B C-234

A two-stage automated drying system of which stage one involves high-velocity air movement with mechanical stirring of manure in the pit, and stage two consists of use of a commercial dryer to obtain a ten percent moisture content, is described. Test results, with cost data, are reported.

The resulting fine powder is free from odor and can be stored without deterioration. It has proved most effective in regenerating spoil banks in coal-mine areas and highway embankments.

1971-1037
BROMEL, M.; LEE, Y. N.; and BALDWIN, B.
Antibiotic Resistance and Resistance Transfer Between Bacterial Isolates in a Waste Lagoon
Proc. ISLW p. 122-125
Abst: McQ & B C-246

Since the intestinal microflora of domestic animals include many bacterial species that are similar to those in man's intestine, incorporating such antibiotics as tetracycline into animal feeds may result in permanent drug resistant populations in man because of transferable drug resistance between similar genera. These resistant organisms may then limit the usefulness of antibiotics in combating later infections in man and his domestic animals."

Such resistant bacterial isolates were common in samples from solid bovine wastes, farm animal waste lagoons, and the Red River of the North which receives treated and untreated wastes from municipalities, food-processing industries, and feedlots. "The same water source is used for potable, irrigational and industrial purposes."

1971-1038
BROWN, Robert H.
Handling Waste Materials: A Look at How a Hatchery Does It
Feedstuffs 43: 25 Sept. p. 33-34

Drying, with use of the residue as a source of protein and calcium in animal feeds, or modern incineration are acceptable methods of disposing of hatchery wastes. An incinerator in Winterville, Georgia, is described and pictured. Operated 24 hours per day in the 1600°-1800°F range with temperatures controlled to compensate for fuel value of the wastes and with an afterburner to eliminate smoke and odor, the unit eliminates pollution. The ash provides a mineral supplement in feeds. Litter spreading on farmland is under attack by ecologists. Refeeding is not presently acceptable under FDA rulings.

1971-1039
BUCHOLTZ, Herbert F.; HENDERSON, Hugh E.; FLEGAL, Cal J.; and ZINDEL, Howard C.
Dried Poultry Waste as a Protein Source for Feedlot Cattle
Mich. Ag. Ex. Sta. Rsch. Rpt. 136 p. 66-71
Reprint: Mich. Ag. Ex. Sta. Rsch. Rpt. 152 p. 28-31
Abst: McQ & B E-209

Cattle were fed rations containing 12 percent crude protein from soy, urea, DPW, and combinations. Feed efficiency, ranked from best to worst, was soy, urea, 1/2 DPW-1/2 urea, 1/2 DPW-1/2 Soy, and DPW. Costs per cwt of gain were

1/2 DPW-1/2 urea	$14.58
urea	15.03
soy	15.31
1/2 DPW-1/2 soy	16.84
DPW	18.87

The steers avoided the DPW portion of the ration.

1971-1040
BUCHOLTZ, H. F.; HENDERSON, H. E.; THOMAS, J. W.; and ZINDEL, Howard C.
Dried Animal Waste as a Protein Supplement for Ruminants
Proc. ISLW p. 308-310
Abst: McQ & B C-300

Dried poultry waste was fed to feedlot cattle, growing sheep, dairy cows, and calves. Sheep were also fed dehydrated feces from beef cattle, dairy cattle, and pigs. For such delicacies to compete economically with other sources of supplemental nitrogen, it was determined that they must contain more than 25 percent crude protein.

"The steers sorted the shelled corn and corn silage from the well-mixed ration leaving almost as much dry poultry waste as had been presented. . . Sheep readily consumed all rations. . . Goats have refused to consume these rations."

1971-1041
BULL, L. S. and REID, J. T.
Nutritive Value of Chicken Manure for Cattle
Proc. ISLW p. 297-300
Abst: McQ & B C-297

Most feeding tests reported to date have been on chicken litter. This paper reports a series of three tests on air-dried chicken manure (ADM). "Palatability was not a serious diet problem as long as the ADM contained less than 20 percent moisture." Maximum intake of ADM, based on acceptance, was 1.03 to 2.12 kg/day. "All cows will consume enough ADM to meet their protein needs when ADM is the sole source of supplemental N in an otherwise low-N diet." ADM goes particularly well with corn silage since this eliminates a dust problem and masks the odor. Savings of $12 to 15 per ton over nutritionally-equivalent supplements could be realized.

1971-1042
BURNETT, William E
Gases and Odors from Poultry Manure: A Selected Bibliography
Poultry Sci. 50: 61-63
Abst: McQ & B B-293

The bibliography contains three subheadings: 1) the microbiology and chemistry of gas and odor production (seven entries), 2) identification and determination of gases and odors (eleven entries), and 3) odor control methods (seventeen entries).

1971-1043
BUTCHBAKER, A. F.; GARTON, J. E.; MAHONEY, G. W. A.; and PAINE, M. D.
Evaluation of Beef Feedlot Waste Management Alternatives
Proc. ISLW p. 66-69, 72
Abst: McQ & B C-230

For alternative means of handling solid wastes or slurries from open feedlots or confinement buildings of several designs, costs per head are discussed and represented on diagrams. Optimum choices depend upon number of cattle fed, days of operation per year, climate, feedlot drainage area, length of haul of waste for final disposal, etc. The authors conclude that "a manure-irrigation system for handling slurry and flushed wastes costs about half as much as other waste handling methods."

1971-1044
BUTCHBAKER, A. F.; GARTON, J. E.; MAHONEY, G. W. A.; and PAINE, M. D.
Evaluation of Beef Cattle Feedlot Waste Management Alternatives
EPA WPC Rsch. Ser. 13040 FXG 323 p.

Waste handling alternatives were discussed under the headings "open feedlots" and "confinement buildings." Solid handling and runoff-carried or liquid flush methods applied to each. Treatment and ultimate disposal are each accorded a chapter. The methods of ultimate disposal discussed are land disposal, irrigation, evaporation, and incineration. Economic considerations govern the choice among the non-polluting alternatives. Incineration involves risk of air pollution. Use of manure as a fuel is cited as a "promising method."

1971-1045
BYERLY, T. C.
U.S.D.A. Technical and Financial Assistance Programs
Proc. Natl. Symp. on Animal Waste Mgmt. p. 139-141

A number of agencies within the USDA having an interest in some phase or other of animal waste management are mentioned. In particular, the ARS (Agricultural Research Service) is concerned with air and water pollution by feedlots; structures for containing, diverting, or dissipating polluted water; and refeeding of manure after more or less processing.

1971-1046
CALLIHAN, C. D. and DUNLAP, C. E.
Construction of a Chemical-Microbial Pilot Plant for Production of Single-Cell Protein from Cellulosic Wastes
EPA Report SW-24c viii + 126 p.

The cellulosic material involved in the pilot plant study was bagasse. This was converted into bacterial single-cell protein by fermentation.

1971-1047
CALVERT, C. C.
Feed Additive Residues in Poultry Manure
Poultry Digest 30: 396-398

This extract from ARS 44-224 considers the various additives common in chicken feeding and attempts to evaluate their pollution potential. In most cases, information is sketchy. Antibiotics, arsenicals, and nitrofurans pose the greatest hazard.

1971-1048
CALVERT, C. C.
Fecal Residues from Feed Additives -- Poultry
USDA ARS 44-224 p. 14-19

As a contribution toward the evaluation of the potential hazard of poultry feed additives, CALVERT considered the various types having FDA approval, quoted pertinent references to them in the literature, and ventured an opinion on their prevalence and toxicity. Pellet binders, flavoring agents, and enzymes would appear to pose little threat. Antibiotics, arsenicals, and nitrofurans fed at low level as growth adjuvants should be carefully evaluated as possible pollutants; more information is needed than is presently available. Antifungal additives would appear to be safe. Medications for specific diseases require analysis on an individual basis.

1971-1049
CALVERT, C. C.; MORGAN, N. O.; and EBY, H. J.
Biodegraded Hen Manure and Adult Flies: Their Nutritional Value to the Growing Chick
Proc. ISLW p. 319-320
Abst: McQ & B C-303

Research has been conducted at Beltsville, Maryland, to determine if large quantities of house fly larvae could be grown on chicken manure to change its characteristics, if the larvae could be harvested efficiently, and if larvae or later stages could be used as protein sources for chicks.

Experiments are described and an analysis of the composition of dried ground fly pupae is tabulated. "House fly larvae can be used to process or biodegrade caged laying hen manure. The degradation removes obnoxious odor, reduces moisture and volume of the manure. The larvae, after pupation, or emergence as adult flies, can be used as a protein supplement for the growing chick."

1971-1050
CAMPBELL, J. Phil
Improved Control of Animal Wastes
Proc. Natl. Symp. on Animal Waste Mgmt. p. 7-9

Land recycling is not always economically feasible. Recycling, pyrolysis, and incineration may be applicable. Financial assistance must be forthcoming to aid the livestock-poultry industry in waste disposal.

1971-1051
CARLSON, Lee G.
A Total Biochemical Recycle Process for Cattle Wastes
Proc. ISLW p. 89-91
Abst: McO & B C-236

The Babson Chemical Recycle Process is reported to accept cattle wastes and to return undigested solids, squeeze-dried, of a quality usable as bedding or roughage. The liquid resulting may be "processed to any degree of purity desired by ion-exchange and charcoal treatment, and also by ultra-violet exposure if potable water is desired." Resulting floc may be stored and used as a fertilizer.

1971-1052
CATH, William Stanwood
Summary of Existing State Laws
Proc. Natl. Symp. on Animal Waste Mgmt. p. 17-18
Abst: McO & B C-217

Eight states have specific feedlot statutes and/or regulations. All states have adopted water quality standards. Construction of facilities with zero runoff except under catastrophic rainfall conditions is permitted without prior consent in 29 states. Control is tightening.

1971-1053
CHANG, A. C.; DALE, A. C.; and BELL, J. M.
Nitrogen Transformation During Aerobic Digestion and Denitrification of Dairy Cattle Wastes
Proc. ISLW p. 272-274, 278
Abst: McQ & B C-289

Loss of nitrogen has been reported in analyses of the behavior of oxidation ditches. This paper reports on laboratory studies on the phenomenon which was found to be caused partly by the volatilization of ammonia and partly by the denitrification.

1971-1054
CLAWSON, W. James
Economies of Recovery and Distribution of Animal Wastes
Jnl. Animal Sci. 32: 816-820
Abst: McQ & B B-237

Disposal of animal wastes is unlikely to show a profit. Realistic accounting procedures call for its being regarded as a cost associated with confined animal feeding.

1971-1055
CLAYBAUGH, Joe W.
The Fallacy of Deep Pits for Poultry Houses
Feedstuffs 43: 6 Feb. p. 36
Abst: McQ & B F-102

The major disadvantage of a deep pit is the deterioration in nutrient quality of the manure. Others are the additional cost of the building, the possibility of water leakage leading to anaerobic conditions in the pit, and the attraction of a deep pit for home-seeking rodents. To obtain good air flow patterns, separate ventilating systems may be required for birds and pit.

1971-1056
COLEMAN, Eugene A.
Crop Response to Waste Materials from Various Feedlot Collection Systems
Soil Conservation Service -- Texas Tech Workshop. Lubbock. 28-29 July. 6 p.

Findings to date on runoff from beef cattle feedlots indicate that the concentration of solutes is highly variable. Concrete-surfaced lots produce the stronger runoff; concentration increases with slope on dirt-surfaced lots. Plant species vary in their tolerance of feedlot effluent. It is detrimental to plant germination but there is reason to believe that greater knowledge will convert this nuisance to a resource.

1971-1057
COLEMAN, Eugene A.; GRUB, Walter; ALBIN, Robert C.; MEENAGHAN, George F.; and WELLS, Dan M.
Cattle Feedlot Pollution Study: Interim Report Number 2 to Texas Water Quality Board
Texas Tech Water Resources Center Pbln. WRC 71-2. vii + 12 p.

The second interim report, devoted primarily to continued agronomic studies, emphasized that land disposal of feedlot runoff in semiarid areas entails risks of severe salt damage. The conclusions of the first interim report [1969-1087] were reaffirmed and four additional conclusions and recommendations were added:

1. With proper management and judicious timing, runoff from feedlots can be used to advantage for the irrigation of some field crops.

2. Cattle feedlot runoff should never be applied as a preplant irrigation or as an irrigation treatment on seedling crops.

3. Feedlot runoff can have a beneficial effect on cotton and bermuda grass.

4. Additional research on both runoff and solid waste disposal is called for.

1971-1058
CONCANNON, Thomas J., Jr. and GENETELLI, Emil J.
Groundwater Pollution Due to High Organic Manure Loadings
Proc. ISLW p. 249-253
Abst: McQ & B C-283

To evaluate two different methods of measuring possible groundwater contamination resulting from high organic loadings, the authors tested total organic carbon, nitrate, NH_4^+, SO_4, PO_4, Cl^-, Na, Mg, Ca, and K in soil cylinders loaded with 0, 15, 30, and 45 tons of dry poultry manure per acre. Results are tabulated. In general, little effect was detected at depths of four feet. "Planting and harvesting a crop could decrease contaminant levels. Water percolation to groundwater from disposal areas of this type is subjected to substantial dilution."

1971-1059
CONNOLLY, John A. and STAINBACK, Sandra E.
Solid Waste Management: Abstracts from the Literature -- 1964
EPA Pbln. SW-66 280 p.

Abstracts of 977 publications on solid wastes classified under 19 headings with indexes by author, corporate author, geographical location, and subject are included. The papers on Agricultural Wastes, numbered 64-0344 through 64-0402, appear on p. 76-94. Nineteen of the abstracts are based on the Second National Symposium on Poultry Industry Waste Managment held at the University of Nebraska, Lincoln, 19-20 May, 1964. A few of the agricultural papers are on crop residues or processing plant wastes, but the great majority deal with manure.

1971-1060
CONRAD, J. H. and MAYROSE, V. B.
Animal Waste Handling and Disposal in Confinement Production of Swine
Jnl. Animal Sci. 32: 811-815
Abst: McQ & B B-236

The ideal system of swine raising would optimize hog production considering labor, costs, feed and manure management, etc. Confinement feeding may be expected to continue. Disposal systems will probably continue to have slotted floors over oxidation ditches or to provide for periodic flushing to aerobic lagoons, with lagoon water being recirculated for flushing and with excess water being disposed of by irrigation. Plow-furrow-cover disposal of sludge is regarded as the best means of solids disposal.

1971-1061
CONRAD, R. Deane
Developing New State Legislation/Model State Statute for Animal Waste Control
Proc. Natl. Symp. on Animal Waste Mgmt. p. 27-32

A proposed model feedlot act of undesignated origin is presented as Appendix A. Modifications are suggested in the paper.

1971-1062
CONVERSE, James C.; DAY, Donald L.; PFEFFER, John T.; and JONES, Benjamin A., Jr.
Aeration with ORP Control to Suppress Odors Emitted from Liquid Swine Manure Systems
Proc. ISLW p. 267-271
Abst: McQ & B C-288

The swine producer who recycles waste back to the land does not require complete degradation. The purpose of the investigation reported in this paper was to determine the cut-off point at which odor would not constitute a problem. [ORP is an abbreviation for Oxidation Reduction Potential].

1971-1063
DALE, Alvin C.
Disposal of Dairy Cattle Wastes by Aerobic Digestion
EPA Pbln. SW-5r.2, p. 19-21

A combination of aerated lagoons and irrigation appears to be an excellent method of disposal for dairy cattle wastes. It is essentially odorless; it provides a place to dispose of wastes at all times; it provides for the returning of a large part of the nutrients to the land; with proper management, it minimizes runoff; it lowers pollutional characteristics; and it has moderate costs of installation, operation, and labor.

1971-1064
DALE, A. C.
Status of Dairy Cattle Waste Treatment and Management Research
Proc. Natl. Symp. on Animal Waste Mgmt. p. 85-95
Abst: McQ & B C-339

DALE summarizes dairy operations. In general, small herds with adequate land holding for spreading exist. Sanitarians tend to approve return to the soil and to view oxidation ditches and aerated lagoons with suspicion. Anaerobic lagoons are even less reputable.

Composting and drying have some advocates, especially in warm, arid settings. Direct irrigation is used in some places. Pyrolysis and incineration have received little consideration though they have the advantages of "volume reduction and production of dry and innocuous residue." Direct recycling "has been accomplished by ANTHONY with some relative good results. At least it did not appear to be detrimental to the dairy cows."

Other methods listed without comment or reference are:

"1. Making into building blocks with glass
2. Squeezing into oil
3. Using hydroponically to produce plants
4. Synthesizing into proteinaceous materials and other products
5. Transported by beetles to soil
6. Placing in landfills
7. Feeding fish
8. Growing algae
9. Producing methane and other gases.

Each method has some merits but most of them do not offer an economically sound method for treatment, handling and disposal. Of course, as the size of operation increases, some of these methods may become more feasible. However, until that time, the direct or indirect return of wastes to the soil to support plant growth appears to be the more feasible way to handle dairy cattle wastes."

1971-1065
DAY, Donald L.
Livestock Waste Management and Sanitation
EPA Pbln. SW-5r.2, p. 25-26

By employing an oxidation ditch beneath self-cleaning slotted floors in a confinement livestock building with the supernatant flowing to an aerobic lagoon to await irrigation use at convenient times, the criteria of low labor cost, low odor, prevention of stream pollution, simplicity of operation, and economic feasibility are very nearly satisfied. Chemical treatment of the liquid manure accomplished less at greater cost.

1971-1066
DAY, Donald L.; JENSEN, A. H.; and BAKER, D. H.
Liquid Feeding of Oxidation Ditch Mixed Liquor to Swine (Abst)
Jnl. Animal Sci. 33: 1149

Liquor from an oxidation ditch containing three percent dry matter and maintained at 3.5 ppm oxygen is pumped daily to a stainless steel vat to eliminate chance feeding of fresh excreta. The liquor, substituted for water in a swine ration, was available *ad libitum*. Weight gain and feed efficiency were greater in the pigs on liquor than in those on water.

1971-1067
DAY, Donald L.; JONES, Don D.; CONVERSE, James C.; JENSEN, A. H.; and
    HANSEN, Edwin L.
Oxidation Ditch Treatment of Swine Wastes
Agr. Engrg. 52: 71-73 [ASAE Paper 69-924]
Abst: McQ & B B-647

Based on model and prototype tests, design values are proposed for an oxidation ditch extending under a slotted-floor hog house. Ditch volumes of 12 cu ft/hog with a 1-to-2 ft depth of ditch and about 3:1 ditch depth to rotor submergence is recommended.

By extending under the floor, the ditch is close to its source of supply and receives it at a nearly constant rate. Odors can be controlled by good housekeeping.

The effluent should not be discharged directly to a stream.

1971-1068
DENNISTOUN, Rollin M.
The Minnesota Scene: Livestock Feedlot, Waste Control, Progress-Problems
Proc. Natl. Symp. on Animal Waste Mgmt. p. 33-35

The Minnesota Pollution Control Agency promulgated regulations on feedlot construction and/or operation in April, 1971. The author anticipates trouble in interpretation - enforcement, availability of funds to the feedlot operator to make the capital investments required, education-communication, research, and duplication of agency jurisdiction with resulting confusion in the field. ". . . unless corrective measures are taken, implementation of these regulations will compound the problems of our rural areas."

1971-1069
DEWAR, Jane E.
Intensive Housing of Dairy Herd Concentrates Wastes
AIC Review 26: Nov-Dec. p. 14-17

In cold climates up to six months storage may be necessary for manure to be spread on land. Slotted floors over liquid manure trenches are expensive but efficient. Disposal by sprinkler irrigation is highly desirable, but may involve some problems with clogging. Studies on trouble-free pumps are reported.

1971-1070
DIESCH, Stanley L.
Survival of Pathogens in Animal Manure Disposal
EPA Pbln. 5r.2, p. 35

Pilot studies on beef cattle manure in an oxidation ditch "indicate that a definite potential health hazard exists for man and animals."

1971-1071
DIESCH, S. L.; POMEROY, B. S.; and ALLRED, E. R.
Survival and Detection of Leptospires in Aerated Beef Cattle Manure
Proc. ISLW p. 263-266
Abst: McQ & B C-287

Pathogenic leptospires are capable of survival for up to 18 days in oxidation ditches and 11 days in effluent and sludge. Chlorination or other treatment of contaminated effluent and sludge is needed before it is discharged.

1971-1072
DINIUS, D. A.
Fecal Residues from Hormones and Antibiotics -- Beef Cattle
USDA ARS 44-224 p. 27-32

A review of the literature supports the conclusions that the "uptake of synthetic estrogens from soil by roots of plants is insufficient to be harmful to man or animals consuming them" and that "apparently plants will not absorb from the soil measurable quantities of the antibiotics commonly fed to cattle."

1971-1073
DOMINICK, David D.
Animal Waste Management and the Environment
Proc. Natl. Symp. on Animal Waste Mgmt. p. 11-14

State and Federal legislation and regulations relating to animal wastes are discussed briefly. Many alternate solutions must be developed to meet the wide variety of conditions encountered. Work on recycling and reuse must be intensified. Many presently-known techniques are too expensive to be feasible.

1971-1074
DUFFER, William R.; KREIS, R. Douglas; and HARLIN, Curtis C., Jr.
Effects of Feedlot Runoff on Water Quality of Impoundments
EPA, WPC Rsch. Series 16080 GGP 54 p.

The results of feedlot runoff reaching a farm pond and a reservoir were disastrous to the biological populations due to oxygen exhaustion and excessive ammonia. The authors present the results of measurements of chemical compositions and populations of aquatic organisms following several runoff events. Their recommendations are

"1. Present volumes of rainfall runoff, draining to surface waters from feedlots, should be significantly reduced.

2. Feedlot waste management practices which would reduce the concentration of pollutants in rainfall runoff should be established.

3. In addition to considerations such as availability of feed, animals, and markets, future establishment of feedlot operations should require incorporation of geographical and topographical features which are conducive to efficient control of wastes and runoff drainage.

4. Waste treatment methods should be developed and tested for application to feedlot rainfall runoff which drains to surface waters."

1971-1075
DUNAWAY, Bob
What Cost to Stop Feedlot Pollution
Wallaces Farmer 96: 27 Feb. p. 24

Costs for the earthwork in providing runoff control for 15 feedlots in Iowa are tabulated. They range from $0.89 per head for a lot handling

1450 cattle to $7.00 per head for a 100-head lot. An irrigation system would add to these costs, but might also provide substantial benefits.

1971-1076
DUNAWAY, Bob
Guides for Feedlots on Pollution Control
Wallaces Farmer 96: 13 Mar. p. 30

The Iowa feedlot control law requires registration of all lots of over 1000-head capacity and of other lots near streams, wells, and sinkholes. Storage must be provided for three inches of surface runoff over the watershed, a solids settling basin must be capable of holding one inch of solids over the feedlot, and a means of disposal of the liquid from the retention pond must be provided.

1971-1077
EDWARDS, W. M.; CHICHESTER, F. W.; and HARROLD, L. L.
Management of Barnlot Runoff to Improve Downstream Water Quality
Proc. ISLW p. 48-50
Abst: McQ & B C-225

For a small barnyard in east-central Ohio from which drainage to a creek occurred through a 500-m grassed channel, the concentration of nutrients was less at the creek than at the barnyard due primarily to the dilution effect of the additional contributing area. Disposal by sprinkler irrigation on pasture in the same drainage area after storage for several days in a rubber-lined pit "produced no noticeable improvement in quality at the waterway outlet during the following 8 months."

1971-1078
EFTINK, Bill
Oxidation Ditches: Their Progress and Problems
Successful Farming 69: Aug. p. 28-29

Oxidation ditches eliminate odors (when functioning properly) and reduce volume of solids. By irrigating from a lagoon it may be possible to eliminate manure handling. Costs -- capital, operating, and maintenance -- tend to be higher than those of other manure handling systems. Users quoted were generally satisfied.

(See also EFTINK: "New Propeller System for Oxidation Ditches." Dec. p. 16).

1971-1079
EICHE, Carl
Recycling Animal Wastes Gets a Closer Look
Prairie Farmer v. 143, 3 July, p. 12

Research at the University of Maryland, Michigan State, Virginia Polytechnic, Auburn, Worchester (England), and Beltsville, Maryland, is reported. At Beltsville, pupae and adult houseflies, raised on manure, have been fed to poultry. Uncertainties remain as to the residues of drugs fed as additives.

1971-1080
EICHE, Carl
Drying Wastes May Be the Answer to Disposal
Prairie Farmer v 143, 21 Aug., p. 50-51

Poultry manure is being dried at costs of from $10 to 30 per ton. Sold in bulk, it brings $6 to 20 per ton. In bags it sells for 2 to 29 ¢ per pound. Uses are for lawns and gardens, mushrooms, orchards, and crops.

Ohio State University is studying pyrolysis to produce fuel. When raised to 800°C in the absence of free oxygen, fuel values are 7200 Btu/lb for poultry, 6400 for beef cattle, 5500 for swine, and 5000 for dairy cattle.

1971-1081
EICHE, Carl
Waste Water Irrigation Should Become Popular
Prairie Farmer v. 143, 4 Sept., p. 60

Spreading waste water from lagoons or storage pits is "about the only practical way to handle waters that run off huge cattle feedlots. And it fits numerous dairying and swine operations as well." Research at Washington State, Florida, Auburn University, Michigan State, and Georgia, is reported. Health problems may arise.

1971-1082
EICHE, Carl
Waste Disposal Can Cause Crop Damage
Prairie Farmer v. 143, 16 Oct., p. 16

Excess fertilizer can be detrimental even if plowed in upon application. Caution is necessary in the application of liquid manure, lagoon effluent, etc.

1971-1083
ELAM, Lee
Cows Rest on Manure Mattresses
Hoard's Dairyman 116: 1239
Abst: McQ & B F-087

Operation of a dairy in Washington is described in which the solids are separated from liquid manure. Some are sold at $1 per cu yd for fertilizer which has suffered some nitrogen loss but has retained its other nutrients. The rest is used as stall bedding. Three feet deep when placed, it is compressed to a foot of thickness in use. The liquid manure is used for irrigation.

1971-1084
ELMUND, G. Keith; MORRISON, S. M.; and GRANT, D. W.
Proc. ISLW p. 174-175
Abst: McQ & B C-260

"Studies have been conducted to evaluate the use of various hydrolytic enzymes to hasten microbial decomposition of feedlot manure. Methods to evaluate and optimize conditions for enzymatic hydrolysis and bioassay techniques to measure increased rates of microbial activity have been developed."

". . . enzyme activity is affected by numerous physical and chemical factors, i. e., moisture, temperature, pH, substrate availability and the presence of protein denaturing agents such as urea or metallic poisons. Effective and economical use of hydrolytic enzymes may require the modification of manure handling and treatment techniques."

1971-1085
ESMAY, Merle L. and SHEPPARD, C. C.
Drying of Poultry Manure in a Cage-Layer House
Mich. State Univ. Ag. Ex. Sta. Rsch. Rpt. 152 p. 17-27
Abst: McQ & B E-208

A hen produces about two-thirds of a pound of water per day, about half in respiration. Somewhat over 2000 Btu/lb are required to evaporate water from chicken feces. The cost would be about 1 ¢ per pound of water. The process is less than fifty percent efficient with the waste heat raising the temperature of the building. Since odor problems are greatest in summer, the utility of electrical heating as an air pollution control measure is questionable.

1971-1086
EXON, J. James
Luncheon Address
Proc. Natl. Symp. on Animal Waste Mgmt. p. 53-56

The speaker, Governor of Nebraska, observed that stream pollution in Nebraska when millions of buffalo protected themselves from flies and gnats by acquiring mud coats was worse than it has even been since. Agriculture is entitled to protection from encroachment by suburbia, to financial assistance in making the capital outlay required to prevent pollution, and to a more secure and rewarding status.

1971-1087
FEE, Rodney, J.
Iowa State's Labor-Free, Low Odor Waste Handling System
Successful Farming 69: Dec. p. 16

An 800-head swine finishing unit is equipped with gutters flushed automatically to an anaerobic lagoon. Supernatant from the lagoon is pumped to a tank to become flushing water. Excess water is pumped to irrigation. Capital costs are about $5 to $10 per hog capacity.

1971-1088
FELDMANN, H. F.
Pipeline Gas from Solid Wastes
AIChE, 69th Mtg., Paper 6d 18 p.

Among the potential advantages of converting municipal solid wastes (MSW) into pipeline gas are that: (1) the large metropolitan areas generate the waste and require the gas, (2) garbage is in abundant supply while gas is short, (3) MSW has the chemical composition to be a good feed material for a pipeline gas plant and to have a negative price, (4) the high value of pipeline gas justifies the capital expenditures for plant, and (5) environmental gains would result from converting solid waste to a much smaller volume of sterile residue and a clean burning gas.

Garbage can be supplemented with manure to advantage. "Conversion of this manure [U. S. total production of 1.3 billion tons/yr (dry basis)] to methane could supply the entire United States consumption of natural gas (based on 1966 figures)!"

1971-1089
FLEGAL, Cal J. and DORN, D. A.
The Effects of Continually Recycling Dehydrated Poultry Wastes (DPW)
on the Performance of SCWL Laying Hens -- A Preliminary Report
Mich. State Univ. Ag. Ex. Sta. Rsch. Rpt. 152 p. 45-48
Abst: McQ & B E-211

The first 14 cycles of a project in which groups of chickens were fed rations containing 0, 12.5, and 25 percent DPW with the feces being collected every 12 days, dried, and refed to the same group of birds is reported on. Calcium and phosphorus tended to increase after cycle 10. The chickens on 25 percent DPW ate more to compensate for reduced energy content. The experiment will continue.

1971-1090
FLEGAL, Cal J. and ZINDEL, Howard C.
Dehydrated Poultry Waste (DPW) as a Feedstuff in Poultry Rations
Proc. ISLW p. 305-307
Abst: McQ & B C-299

With leghorn type laying hens, the body weight at four weeks and egg-laying efficiency were not influenced when the ration consisted of up to 20 percent DPW. Egg quality was unaffected at 40 percent. With broilers, the feed efficiency was related inversely to the level of DPW in the diet. A taste panel detected no difference in eggs from chickens fed 0, 10, 20, and 30 percent DPW.

1971-1091
FLEMING, Bill
Think Disposal -- Not Control!
Beef 7: Apr. p. 4-5

Dumas Cattle Feeders of Dumas, Texas, have developed a sound waste handling system. They divert inflow around the feedlot and drain the feedlot to a lagoon in an abandoned quarry. Water from the lagoon, diluted by recaptured irrigation tailwater and whatever well water a farmer wishes to add is used for irrigation. When the lagoon is dry, the solids are removed and sold for fertilizer. By controlling the cattle feed, the manure is free of weed seeds.

1971-1092
FLEMING, Bill
Recycling Used to Clean Barn
Beef 8: Nov. p. 16-17

To decrease costs associated with confined feeding, Iowa Beef Processors is testing the feasibility of using a barn floor of concrete with slats forming parallel channels which drop 14 inches in 32 feet. Effluent pumped from an outside lagoon flushes the channels in returning to the lagoon. Apparently some aeration will be necessary to make the process odor-free. Hair in the effluent occasionally blocks channels. Freezing-weather performance is yet to be tested.

1971-1093
FOGG, Charles E.
Livestock Waste Management and the Conservation Plan
Proc. ISLW p. 34-35
Abst: McQ & B C-221

Return of animal and poultry wastes to the land for recycling is advocated. This requires a careful evaluation of soil and plant cover characteristics. Runoff from feedlots or disposal areas should not be permitted to enter streams, but should be disposed of by spray irrigation, after lagooning if necessary. Storage of manure during periods of excessive precipitation or freezing may be required.

Nitrogen is the most common limiting constituent of animal and poultry wastes with respect to adverse effect on groundwater.

1971-1094
FONTENOT, Joseph P.
Utilization of Broiler Litter as Animal Feed
EPA Pbln. SW-5r.2, p. 99-100

Broiler litter can be sterilized by heating in a forced-draft oven at 150°C for four hours or longer. This causes a loss in crude protein of about 20 percent. No gross toxicological effects were observed in sheep whose diet consisted of up to 75 percent sterilized broiler litter.

1971-1095
FONTENOT, Joseph P.; WEBB, K. E., Jr.; HARMON, B. W.; TUCKER, R. E.; and MOORE, W. E. C.
Studies of Processing, Nutritional Value and Palatability of Broiler Litter for Ruminants
Proc. ISLW p. 301-304
Abst: McQ & B C-298

Broiler litter has traditionally been used as a fertilizer, but its value for this purpose does not justify the cost of handling. "Possibly, a more economical approach to disposal of broiler litter would be to use this waste as animal feed."

"Experiments were conducted to: (a) develop a processing method(s) that will destroy pathogenic organisms in broiler litter; (b) study the effect of sterilizing methods on the nutritional value of litter; (c) study the variation in chemical composition of litter; (d) determine the palatability of rations containing different proportions of broiler litter and (e) assess the magnitude of pesticide residues in broiler litter."

"Broiler litter can be rendered free of pathogenic organisms by heat treatment. There is no serious pesticide residue problem from feeding broiler litter. Perhaps, the only major area of research which needs to be pursued before poultry litter is considered safe as a feed for cattle and sheep is the problem of medicinal drug residues."

1971-1096
FRITSCHI, E. W. and MACDONALD, F. W.
Wastewater from Simian Primate Facilities
WPCF Jnl. 43: 883-889
Abst: McQ & B B-086

Studies at the Delta Regional Primate Research Center in New Orleans indicated that five-day BOD of waste from primates tended to be three to six times that of human wastes. Heavy chlorination is used on the sewage treatment effluent to render it safe for discharge to streams.

1971-1097
FROBISH, L. T.
Fecal Residues from Feed Additives -- Swine
USDA ARS 44-224 p. 19-27

The major items associated with swine production are antibiotics, arsenicals, copper, nitrofurans, sulfonamides, and hormones. Little information is available on the potential buildup of antibiotics in plants fertilized with swine manure. Arsenicals are commonly used but pose little hazard since they are not an accumulative poison except in rats and the margin of safety is quite high. Copper is an effective growth stimulant at beneficial levels, but is toxic at higher levels; present knowledge is inadequate. "There is a void in information on the uptake of excreted nitrofurans by plants, and possible entry into animals. Hormones would appear to pose few threats.

1971-1098
GALLER, William S.
Animal Waste Composting with Carbonaceous Material
EPA Pbln. SW-5r.2, p. 6-7

The objectives of the research reported are "to develop a process for composting a combination of chicken manure as a source of nitrogen and sawdust initially as a source of carbon to produce a valuable soil amendment." Laboratory studies of combinations of manure and sawdust with carbon-to-nitrogen ratios of 25:1 to 40:1 found them to be nutritionally balanced for microbial growth. The compost has proven to be a valuable soil conditioner. Swine manure may also be composted satisfactorily with sawdust although the mixture required a week to become thermophilic as opposed to one to two days for the poultry manure.

1971-1099
GALLER, William S. and DAVEY, Charles B.
High Rate Poultry Manure Composting with Sawdust
Proc. ISLW p. 159-162
Abst: Compost Sci. 13: July-Aug. p. 2 (1972); McQ & B C-256

The authors report on a methodical investigation in which C:N:P ratios (preferably 30 to 50:1:0.2), periods of agitation, initial pH, times and quantities fed to composter, etc., were varied. Efficacy of applications of various amounts of the resulting mulch to various crops was studied.

1971-1100
GILBERTSON, Conrad B.
Beef Feedlots -- A Pollution Problem?
Proc. Agr. and Pollution Seminar, Univ. of Ariz. p. 18-29

"Pollution" from cattle feedlots can be classified as surface water, groundwater, air, and aesthetic. Utilization of manure, rather than disposal, will be the key to the future.

1971-1101
GILBERTSON, Conrad B.; McCALLA, T. M.; ELLIS, J. R.; CROSS, Otis E.; and WOODS, W. R.
Runoff, Solid Wastes, and Nitrate Movement on Beef Feedlots
WPCF Jnl. 43: 483-493
Abst: McQ & B B-084

The effects of feedlot slope and cattle density on quality and quantity of runoff, infiltration of pollutants, and solids accumulation on feedlots were studied in some experimental pens near Mead, Nebraska. Results are tabulated and rainfall-runoff correlation is plotted. Soil content of the solids was higher than normal since these were new lots built on fill. Nitrate movement under the lots was negligible but some occurred just outside the lots. It is recommended that solids be intercepted before runoff enters a detention pond.

1971-1102
GILBERTSON, Conrad B.; McCALLA, T. M.; ELLIS, J. R.; and WOODS, W. R.
Methods of Removing Settleable Solids from Outdoor Beef Cattle Feedlot Runoff
ASAE Trans. 14: 899-905 [ASAE Paper 70-420]
Abst: McQ & B B-057, G-081

Velocities of runoff should be reduced to permit settling. This was accomplished by a batch method utilizing a detention reservoir to trap all flow until settling had occurred; the supernatant was then pumped out. Alternatively, a chain of porous dams accomplished the same objective with continuous flow. With either system basins must be cleaned out and the sludge disposed of. This appears to be more easily accomplished with the chain of porous dams.

1971-1103
GILBERTSON, Conrad B.; McCALLA, T. M.; ELLIS, J. R.; and WOODS, W. R.
Characteristics of Manure Accumulations Removed from Outdoor, Unpaved, Beef Cattle Feedlots
Proc. ISLW p. 56-59
Abst: McQ & B C-227

Quantities and chemical characteristics of accumulated manure on new, unpaved, feedlots near Mead, Nebraska, were measured and the results were tabulated and summarized. Manure was removed twice annually. The characteristics were strongly influenced by weather immediately preceding the cleaning operation. The effects of slope were not apparent. ". . . the large variations in results prevented establishment of basic trends."

1971-1104
GLERUM, J. C.; KLOMP, G.; and POELMA, H. R.
The Separation of Solid and Liquid Parts of Pig Slurry
Proc. ISLW p. 345-347
Abst: McQ & B C-310

In Dutch practice pig urine may be degraded biologically and discharged to public water in a purified form. Preliminary separation in the pen is practiced to keep the amount of sludge as small as possible. By using 0.1 kg/pig of bedding, dung is dry enough to be heaped until it can be spread as fertilizer. Devices for separating liquids from the solids which remain in the slurry are described and evaluated.

1971-1105
GOJMERAC, W. L.
Do Manure Stacks Add to Fly Control Problems?
Hoard's Dairyman 116: 556
Abst: McQ & B F-085

Observation on seventy Wisconsin farms indicate that fly breeding is most apt to occur on moldy feed under drinking cups, not in manure piles. In operations in which manure is stacked rather than hauled to the field daily, more time is available for housekeeping and fewer flies were found.

1971-1106
GOLUEKE, Clarence G.
Comprehensive Studies of Solid Waste Management. Third Annual Report.
EPA Pbln. SW-10rg. xvi + 201 p.

This report continues the analysis of the solid waste problem of the San Francisco Bay area treated in [1970-1029] and [1970-1030]. A series of experiments on the anaerobic digestion of 100 percent sludge; 100 percent steer manure; 50 percent steer manure, 50 percent grass; 50 percent steer manure, 50 percent chicken manure; 100 percent chicken manure; and 50 percent steer manure, 50 percent sludge is reported on p. 99-106. "Although the animal manures were stabilized by digestion and rendered inoffensive, there was virtually no reduction in volume of the material. Destruction of total solids was less than 15%. . ." Further attention is accorded the processes of anaerobic digestion (Ch. IV), biological fractionation (Ch. V), incineration-pyrolysis-combustion (Ch. VI), and wet oxidation (Ch. VII).

1971-1107
GOODRICH, Philip R. and MONKE, Edwin J.
Movement of Pollutant Phosphorus in Saturated Soils
Proc. ISLW p. 325-328
Abst: McO & B C-305

A sandy soil may not adsorb the quantities of nutrients offered and too flat a field may be poorly drained and thus unable to accept much irrigation water. In general, phosphorus is adsorbed on organic particles, iron, and clay. The paper reports on a laboratory study of such adsorption. ". . . continuous flushing as with irrigation may cause the phosphate to move more quickly to greater depths than with intermittent applications."

1971-1108
GOWAN, Douglas
The Disposal of Agricultural Wastes
Effluent and Water Trtmt. Jnl. 11: 303-305, 307-308, 368-372, 670

Basic British law on disposal is reviewed and methods of disposal are discussed in some detail. Disposal to land, particularly in England's damp climate, risks runoff to streams, muddy conditions limiting spreading, and storage problems caused by mud and freezing. Discharge to public sewers, particularly of supernatant, may often be economical. It provides for point-source supervised return to streams. "The implications of this are examined in relation to the assessment of charges for treatment, and the economics which may be effected by pretreatment on the farm."

"Anaerobic treatment has rarely been found to be commercially effective in respect of farm wastes. . . Whilst the methane gas production is of value, BOD/solids reduction is practically and economically difficult. . . Full anaerobic degradation of farm wastes as a possibility, is still only at the research and develonment stage."

1971-1109
GOWDY, Billy Ray
State of Oklahoma Activities in Animal Waste Management
Proc. Natl. Symp. on Animal Waste Mgmt. p. 37-39

The provisions of the "Feed Yards Act" of 1969 are described. Disposal of liquid and solid waste is supervised by the Oklahoma Board of Agriculture. Air pollution is under the jurisdiction of the Oklahoma Department of Health. Suggestions are made for possible improvements.

1971-1110
GRAMMS, L. C.; POLKOWSKI, L. B.; and WITZEL, S. A.
Anaerobic Digestion of Farm Animal Wastes (Dairy Bull, Swine, and Poultry)
ASAE Trans. 14: 7-11, 13 [ASAE Paper 69-462]
Abst: McQ & B B-050, G-060]

High-rate controlled temperature tests were run on the anaerobic digestion of animal wastes to determine optimum loading rate, resulting reduction in volatile matter and BOD, composition of the gases produced, and the settleability and drainability of the resulting sludge. The analyses are tabulated. Ultimate disposal envisaged was land spreading, composting or burning.

1971-1111
GRAVES, R. E.; CLAYTON, J. T.; and LIGHT, R. G.
Renovation and Reuse of Water for Dilution and Hydraulic Transport of Dairy Cattle Manure
Proc. ISLW p. 341-344
Abst: McQ & B C-309

An almost closed system for the transport of manure could result from the employment of screens for removal of coarser material from dairy cattle slurry, with some liquid being returned for flushing and the excess being used for irrigation. Very concentrated slurries have poor settling characteristics and form scum mats and sludges when flow ceases.

Solids removed from the screen and allowed to drain did not develop an offensive odor or attract flies. A bar spacing of 0.020 in. removed over 50 percent of the total solids present.

Screening might also be applicable to runoff from feedlots, duck ranges, etc.

1971-1112
GROSS, Champ

Crude Oil from Manure
CALF News 9: Oct. p. 3

Dr. G. Alex MILLS, Chief of the U. S. Bureau of Mines Energy Research Center in Pittsburgh, has perfected a pilot project in which organic waste and carbon monoxide are subjected to 1200 psi pressure at a temperature of 720°F. "Voila! You've got crude oil!" Two tons of manure yield a ton of oil with a BTU content of 14,000-16,000 per lb, and a ton of water. The low-sulphur oil is excellent for power plants. The nation's total annual manure supply would provide about one-half the nation's annual oil requirements.

1971-1113
GROVES, Wil
Need More Work on Manure Disposal Problems
Wallaces Farmer 96: 8 May p. 49

Dr. Ned BAYLEY, keynoting the International Symposium on Livestock Wastes, listed three priorities for research: 1) get more and better methods of land disposal, 2) get better methods of odor control, and 3) employ systems design to optimize overall operation.

1971-1114
GROVES, Wil
Tests Show Feed Value in Processed Manure
Wallaces Farmer 96: 22 May p. 36

Four papers given at the International Symposium on Animal Wastes dealing with refeeding of animal wastes are summarized. L. S. BULL [1971-1041] discussed the feeding of chicken manure to dairy cattle, L. W. SMITH [1971-1229] described tests of feeding dairy cattle wastes to sheep, Brian HODGETTS [1971-1133] described British practice in recycling poultry wastes, and Lloyd HOLMES [1971-1135] discussed the value of swine manure processed in an oxidation ditch as a feed supplement.

1971-1115
GROVES, Wil
As Application Deadline Nears Uncertainty Clouds Waste Permit Picture
Wallaces Farmer 96: 26 June p. 40

A deadline of 1 July 71 for securing permits to discharge wastes was being interpreted as applying to lots with 1000 animal units or more. Smaller lots might be included later. All operators were advised to provide storage volume to handle a storm with a once in four or five years frequency and to stay alert for further clarifications of policy.

1971-1116
GROVES, Wil
Iowa's Feedlot Waste Disposal Law
Wallaces Farmer 96: 14 Aug. p. 17

Iowa registration is required if a feedlot contains over 1000 head, if it drains to a stream whose watershed above the lot contains over 3200 acres, or if the lot is within two ft for each head of cattle of such a stream. Runoff or overflow must not reach a tile drain, well, sinkhole, etc.

A retention pond capable of holding a three-inch runoff and of being drained to land disposal is usually required. A lot should be protected from inflowing surface water.

1971-1117
GRUB, Walter
Reduction of Feedlot Waste by Stabilization
Soil Conservation Service -- Texas Tech Workshop. Lubbock. 28-29 July. 4 p.

Composting of beef feedlot waste is a feasible process. Composted manure may be stored wet or dry without flies or noxious odors. "Composting requires skilled management to obtain satisfactory results."

1971-1118
HAMILTON, H. E.; ROSS, I. J.; BEGIN, J. J.; and JACKSON, S. W.
Growth Kinetics of Rumen Bacteria in Solutions of Poultry Excreta
Proc. ISLW p. 129-131
Abst: McQ & B C-248

"Only limited research has been completed on treating manure to improve its quality as a feed. Fermentation of manures may provide one means of accomplishing this objective." Results of a series of tests on the manure of laying hens being fed a drug-free diet are reported. "The microbial population per unit volume was almost five times higher in manure solutions than in the rumen fluid used for inoculum. . . The microbial population in the manure solutions increased as much as 10,000 times during fermentation."

1971-1119
HARGROVE, Tom
Test Swine Waste Disposal Systems
Wallaces Farmer 96: 24 July p. 30

Iowa State has installed a gutter system in a hog house with a 100-gal flush lasting 20 sec once an hour. The swine cooperate. Flushings may be routed to an anaerobic lagoon, an oxidation ditch, or the lagoon and ditch in turn. The excess is spread on corn and/or grassland. Flushing water is recirculated.

Water hyacinths are being tested for removal of nutrients from effluents followed by use as cattle roughage. Iowa winters will keep them from becoming a nuisance.

1971-1120
HARMON, B. G.; DAY, Donald L.; HENSEN, A. H.; and BAKER, D. H.
Nutritive Value of Oxidation Ditch Mixed Liquor for Rats (Abst)
Jnl. Animal Sci. 33: 1149
Abst: McQ & B B-243

Liquor from an oxidation ditch under a swine house with three percent dry matter and 3.5 ppm oxygen was screened to remove hairs and bran layers, then freeze dried. The resulting material contained 41.5 percent protein. When used as 0, 4, 8, and 12 percent of rats' diets, weight gains and feed efficiencies were equal and best at 0 and 4 percent.

1971-1121
HART, Samuel A.
Sanitary Engineering Applied to Livestock Manures
EPA Pbln. SW-5r.2, p. 29-30

Solids digestion, manure lagoons, algae ponds, composting, and drying were investigated to find the most feasible methods of handling manure at the farm level. For California conditions, variations of natural drying were preferred.

1971-1122
HARTMAN, Roland C.
Deep Pit Housing: Is It the Answer?
Egg Industry 4: Apr. p. 28-34

Flexibility in cleanout scheduling and increased efficiency are the major advantages of deep pits. Wet manure and rodent attraction are disadvantages. Ventilation is important in humidity control. If the manure is to be dried for refeeding, freshness is of basic concern.

1971-1123
HARTMAN, Roland C. [Editorial]
Recycling First Step
Poultry Digest 30: 56

Howard C. ZINDEL has dried poultry manure from 78 percent to 8 percent moisture content for about $20 per dried ton. Scale effect could be expected to reduce this to $10 to $15 on larger volumes. Glenn BRESSLER quoted $7.60 per ton for a two-step drying 75 percent to 26 percent, 26 percent to 10 percent. Heating in the range of 400 to 1200°F in drying should render manure safe for refeeding.

(Further note, p. 143).

1971-1124
HARTMAN, Roland C.
Biological Fly Control Spreads
Poultry Digest 30: 224-227

Flies become resistant to insecticides. Biological control requires six to eight months before appreciable results occur and continued good management thereafter. Complete removal of manure should be avoided. Excessive moisture and pesticides should be kept off the manure.

1971-1125
HAZEN, Thamon E.
Handling, Treatment, and Disposal of Animal Wastes
EPA Pbln. SW-5r.2, p. 23-24

"An anaerobic lagoon loaded at a rate of 3.5 to 5 lb of volatile solids per 1000 cu ft provided satisfactory preliminary treatment to liquid swine manure. . . Gas, 60 percent methane, was produced at rates of 7.8 to 10.3 cu ft/lb of volatile solids." When lagoon effluent is applied to soil columns, periods of non-application must be observed to permit recovery of soil permeability. The duration of these periods is a function of temperature. Some oxidation ditch data were also determined.

1971-1126
HEATH, Milton S., Jr.
Proposed Animal Waste Pollution Control Legislation in North Carolina
Proc. Natl. Symp. on Animal Waste Mgmt. p. 41-43

Following defeat of proposed legislation in a Committee of the House in 1971, the Legislative Research Commission was directed to study the need for such legislation and report to the 1973 General Assembly. A thorough scrutiny of the subject is anticipated.

1971-1127
HENSLER, R. F.; ERHARDT, W. H.; and WALSH, L. M.

Effect of Manure Handling Systems on Plant Nutrient Cycling
Proc. ISLW p. 254-257
Abst: McQ & B C-284

Greenhouse and field tests on corn yields resulting from the application of fresh, fermented (stacked), aerobic liquid, and anaerobic liquid cattle manure are tabulated and graphed. Fermented and anaerobic liquid manures gave the best results. Time of application made a significant difference in fertilizer value utilized and in quality and quantity of runoff. Late spring was preferable to winter for spreading in Wisconsin. Risks of nitrates reaching groundwater are mentioned.

1971-1128
HEPHERD, R. Q. and CHARLOCK, R. H.
The Performance of an Experimental High-Rate Biological Filtration Tower when Treating a Piggery Slurry
Water Poll. Control 70: 683-692

"Biological waste treatment is one means of overcoming the management problems associated with applying slurry to land, particularly if relatively simple methods of sludge drying or dewatering can be developed. The dry matter output of a treatment plant could then be stored (by stacking in the field or elsewhere) and spread at the appropriate times of year. Moreover, the total quantities of material to be handled could probably be greatly reduced."

Design requirements are listed and test results described. The effluents would be suitable for use for wash down or for irrigation.

1971-1129
HERNANDEZ, John W.
Agricultural Wastes in Arid Zones
In "Health Related Problems in Arid Lands," Southwestern and Rocky Mountain Division of AAAS p. 37-43

Feedlots are a viable industry in arid lands. The greatest threat they pose to an arid environment is probably localized pollution of shallow groundwater rather than runoff to surface streams. "Treatment of feed-lot wastes by lagooning or other methods is not normally required in our region. . . Returning the manure to agricultural lands appears to be the best solution to the problem, particularly if manure can be thinly spread."

1971-1130
HERRICK, John B.
Recycling Animal Waste
A. I. Digest 19: Sept. p. 10

Problems envisioned with recycling are 1) cost, 2) possible disease spread, and 3) effect on the animals. Costs will usually exceed nutritive value; they may be less than alternative disposal. Poultry manure is not recommended because of risk of salmonellosis. Questions of build-up of drugs, hormones, and antibiotics remain unanswered.

1971-1131
HERRICK, John B.
Animal Waste Reuse May Ease Disposal Problems
Wallaces Farmer 96: 11 Sept. p. 131

Recycling of manure for fertilizer or by refeeding deserves intensive studies in economics, in disease potential, and in "carry-over" effects of additives. Solutions having least net cost will vary from place to place and in time. Salmonellosis in poultry litter is typical of problems which may arise. The effects of drugs, hormones, and antibiotics on the health of the second animal and the potential of build-up in the meat have not been fully evaluated.

1971-1132
HILEMAN, L. H.
Effect of Rate of Poultry Manure Application on Selected Soil Chemical Properties
Proc. ISLW p. 247-248
Reprint: Compost Sci. 13: May-June p. 30-31 (1972)
Abst: McQ & B C-282

Chemical analyses of soil following the incorporation of poultry litter show that rather drastic changes occur. These vary considerably from one soil type to another. Poultry litter is a valuable source of potassium, but the supply may be so great as to inhibit germination and growth. Analyses of three soils under various loadings at designated time intervals are represented by charts. In general, an incubation period is needed before planting a crop.

1971-1133
HODGETTS, Brian
The Effects of Including Dried Poultry Waste in the Feed of Laying Hens
Proc. ISLW p. 311-313
Abst: McQ & B C-301

In a British test the flock performed slightly better overall on a ration consisting of ten percent DPW. Flock health remained good. Growth of mold on a damp sample of DPW indicated the importance of using fresh material and keeping it dry. Possible adverse consumer reaction must be weighed.

"It was noticed that particles of DPW were selected in favor of particles of mash." Cost savings of about 44 ¢ per bird were achieved.

1971-1134
HOLLEMAN, K. A.; WALKER, W. S.; KISSAM, J. B.; and WELTER, J. F.
A Multi-Agency Cooperative Effort to Educate Poultrymen in Pollution
and Fly Control (Abst)
Poultry Sci. 50: 1585-1586
Abst: McQ & B B-300

Seven pollution-and-nuisance schools were held thoughout South Carolina. Topics covered were 1) legal aspects of fly production, air and water pollution and nuisance problems, 2) manure management and disposal, 3) chemical control procedures, and 4) pesticide problems.

1971-1135
HOLMES, L. W. J.: DAY, Donald L.; and PFEFFER, J. T.
Concentration of Proteinaceous Solids from Oxidation Ditch Mixed-Liquor
Proc. ISLW p. 351-354
Abst: McQ & B C-312

The suspended solids in oxidation ditch mixed-liquor have a crude protein content of 27.7 percent (dry weight basis). When substituted at ten to twenty percent of the ration for other proteins in rats' diet, no significant reduction in gain occurred.

Recovery of the suspended solids by settling is unsatisfactory. Addition of floc might have undesirable effects on the animals' health. Centrifugation has proven to be effective. Little time and nominal costs are involved.

1971-1136
HOWES, James R.
Effects of Processing Poultry Manure on Disease Agents
EPA Pbln. SW-5r.2, p. 31-33

Drying is effective in destroying pathogens in poultry wastes provided a temperature of 200°F is reached for a few minutes. Composting of litter with reuse of the composted litter is advisable.

1971-1137
JEDELE, D. G.
Confinement Feeding -- Pros, Cons and Tips
Livestock Mgmt. 13: Jan. p. 21-23, 50

Among the advantages of confined feeding are the elimination of surface runoff, maintenance of fertilizer value of manure by protecting it from sun and rain, and saving in labor in manure handling. An oxidation ditch under the barn helps eliminate odors, but may have high operating costs and be subject to overloading and mechanical failure. Land spreading with incorporation of the manure into the soil is effective. Chemical control of odors may be perfected.

1971-1138
JONES, Don D.; DAY, Donald L.; and GARRIGUS, Unson S.
Oxidation Ditch in a Confinement Beef Building
ASAE Trans. 14: 825-827 [ASAE Paper 69-925]
Abst: McQ & B B-054, G-067

Operation of an experimental oxidation ditch under a slotted-floor confinement beef building for four months, March through June 1969, at the University of Illinois, is described and analyses are tabulated. The "satisfactory" operation was labor saving and odor free. Costs are about 1 ¢ per lb gain.

1971-1139
JONES, Elmer E., Jr.; WILLSON, George B.; and SCHWIESOW, William F.
Improving Water Utilization Efficiency in Automatic Hydraulic Waste Removal
Proc. ISLW p. 154-158

In an attempt to secure better matching of scour and transport capacity, the authors reviewed the literature of sediment transport and studied behavior of model and prototype gutters. Animal behavior patterns are important to the success of water-economizing flushing. Hence, it was recommended that funds be made available for short-term facility evaluation and, perhaps, modification.

"Automatic hydraulic waste removal could reduce initial capital and operating costs, provide a better livestock environment and cut waste management costs. With the current farm cost-price situation and emphasis on pollution abatement, hydraulic waste removal should be rapidly developed."

1971-1140
JONES, K. B. C.
Farm Waste Disposal -- An International View
Agriculture 78: 521-524
Abst: McQ & B E-023

This is a report by an Englishman in a British journal on the International Symposium on Livestock Wastes. In hoping to report material of particular value in the UK, he summarizes impressions, then devotes half his space to a discussion of oxidation ditches.

1971-1141
JONES, K. B. C.
The UK Reconciliation of Modern Intensive Livestock Farming With a Basically Urban Society
Proc. ISLW p. 92-94
Abst: McQ & B C-237

If evenly spread, the manure production of the UK would be about four tons/acre. Loadings of 10-18 tons/acre are common. Disposal, now and in the future, can be expected to be to the land.

Large units are increasing and the labor force is declining. Effective laws exist to control pollution and establish agricultural zoning to restrict urban encroachment.

1971-1142
JORDAN, Herbert C.
Marketing Converted Poultry Manure
Proc. ISLW p. 197-198
Abst: McQ & B C-268

Based on 23 answers to 95 questionnaires sent out over the U. S. between 1961 and 1969, bagged poultry manure had an overall cost of 0.8 to 2.5 ¢/lb in large bags and 8 ¢/lb in small bags. Selling prices were $6 to 20 per ton in bulk, 2 to 29 ¢/lb in bags with 6.4 ¢/lb being the average bag price.

1971-1143
KAMPELMACHER, E. H. and VAN NOORLE JANSEN, Lucretia M.
Reduction of *Salmonella* in Compost in a Hog-Fattening Farm Oxidation Vat
WPCF Jnl. 43: 1541-1545
Abst: Compost Sci. 13: Mar-Apr. p. 2; McQ & B B-088

In a hog-fattening farm in the Netherlands, measurements for *Salmonella* were made in raw manure and in the effluent from an oxidation vat. A hundred-fold reduction occurred. The vat is charged daily with a mixture of 0.6 cu m of manure and 1.9 cu m of water. An aerator rotor runs continuously for 23 hours. After the 1-hr shutdown, effluent is drawn off and the vat is charged.

1971-1144
KIESNER, Jack
More Technology Than Money Available for Waste Control

Feedlot Mgmt. 13: Dec. p. 34, 36, 38
Abst: McQ & B F-060

Costs of pollution prevention cannot be borne by the livestock industry without substantial additional aid in the opinion of many participants in a three-day National Symposium on Animal Waste Management held at Warrenton, Virginia. Papers are summarized briefly. Preliminary recommendations of the Conference included calls for removing the "missing links in existing technology" to qualify for FDA approval of recycled feed products, and a public relations campaign to gain consumer acceptance of refeeding. "The most favorable economic use of livestock wastes is recycling for animal feeds. More research is needed." Land zoning and information programs were also emphasized in the nineteen recommendations.

1971-1145
KOELLIKER, J. K.; MINER, J. Ronald; BEER, C. E.; and HAZEN, T. E.
Treatment of Livestock-Lagoon Effluent by Soil Filtration
Proc. ISLW p. 329-333
Abst: McQ & B C-306

Results of a three-year field and laboratory investigation of the disposal of anaerobic swine lagoon effluent by sprinkler irrigation in Iowa are reported. With application of 14.8 to 31.4 inches per season, COD reductions were 79 to 93 percent, phosphorus reduction was 90 to 97 percent, and nitrogen reduction was 48 to 67 percent. Higher reduction percentages accompanied lower rates of application.

1971-1146
KOTTMAN, Roy M and GEYER, Richard E.
Future Prospects for Animal Agriculture
Proc. ISLW p. 9-18
Abst: McQ & B C-215

Projections for animal and poultry production in the United States through the year 2000 indicate substantial increases. "Long before the year 2000, large quantities of animal wastes will be processed and recycled back through livestock." In addition, recent research at the Ohio Agricultural Research and Development Center has shown that cattle and sheep do well on rations consisting of one-fourth to one-half processed garbage. Recycling studies are reported to be under way at Botkins, Ohio.

1971-1147
LARSON, Russell E. and MOORE, James A.
Beef Wastes and the Oxidation Ditch Today and Tomorrow
Proc. ISLW p. 217-219
Abst: McQ & B C-274

Oxidation ditches can be run on a batch, rather than continuous, basis in regions with sub-zero weather. In such circumstances they should be entirely enclosed under the floor of a slatted-floor shed and, perhaps, supplied with supplemental heat. Competent supervision is required. Such operation accomplishes temporary odorless storage, but not treatment. Further study is required.

1971-1148
LAURA, R. D. and IDNANI. M. A.
Increased Production of Biogas from Cow Dung by Adding Other Agricultural Waste Materials
Jnl. Sci. Fd. Agric. 22: 164-167
Abst: Compost Sci. 13: Nov-Dec. p. 3 (1972); McQ & B B-372

Increased gas production resulted from the addition of casein, urine, dried leaves, or sugar cane. The sugar cane produced the gases richest in methane. The urine and dried leaves seemed to be the most practical additives.

1971-1149
LAUSER, Greg
Two-Stage Drying for Manure Disposal Advocated by Penn State Poultryman
Feedstuffs 43: 31 July p. 7, 33

Glenn BRESSLER considers the deep pit to be the worst possible "solution" to poultry manure disposal. When the day of cleanout finally arrives, the sticky, odiferous mess will have lost its fertilizer value. Liquid handling pollutes large volumes of waters with resulting higher costs for low-pollution disposal. Two-stage drying, with the first stage occurring in place and reducing the moisture content from 75 percent to 35 percent, is advocated. Cost data are cited.

1971-1150
LAWSON, Larry G.
State of Virginia Activities in Animal Waste Management
Proc. Natl. Symp. on Animal Waste Mgmt. p. 45-47

The Virginia State Water Control Law of 1946 was amended in 1970 to be applicable to feedlots with point sources of discharge. Standards for disposal lagoons were drawn up but never adopted. No direct discharge from lagoons to waterways in permitted; evaporation and/or irrigation is required for the effluent. Cooperation with operators, state, and federal agencies has been excellent.

Control of diffused discharge is needed to protect shellfish.

1971-1151
LEE, Hong Y. and OWENS, Thomas R.
Cost of Maintaining Specified Levels of Water Pollution Control for Confined Cattle Feeding Operations for the Southern High Plains
Proc. ISLW p. 207-208, 216
Abst: McQ & B C-271

On the Southern High Plains, runoff from feedlots can be spread on open fields or diverted to playa lakes to be disposed of by evaporation. Evaporation from ponded liquid manure tends to be much less than from open water and risks of ground water pollution occur. Periods of intense storms cause overflow.

Covered pens to exclude rainfall would increase the capital investment in feedlots by a factor of three and would necessitate abandonment of present lots. Better efficiency and reduced cost of manure disposal, however, should repay the added costs in about 45 months.

Disposal by dilution with fresh water and use for irrigation is advocated.

1971-1152
LEFKE, Louis W.; KEENE, Alvin G.; CHAPMAN, Richard A.; and JOHNSON, Henry
Summaries of Solid Waste Research and Training Grants - 1970
EPA Pbln. SW-5r.2 vii + 134 p.

Nineteen of the projects listed are abstracted separately. Several others may have valuable carry-over information applicable to the management of animal waste. In each case the objectives, procedures, and findings are stated. A list of publications accompanies many of the reports.

1971-1153
LIGGETT, Lyle
No Solid Answers Come Out of Nat'l Animal Waste Symposium
Beef 8: Nov. p. 38-39

The first "National Symposium on Animal Waste Management," held at Warrenton, Virginia, highlighted the inconsistencies in current data. No firm conclusions were reached on solutions to be adopted. Many of those under study appear to be inherently expensive.

1971-1154
LIPSTEIN, Bianka and BORNSTEIN, S.
Value of Dried Cattle Manure as a Feedstuff for Broiler Chicks
Israel Jnl. of Agr. Rsch. 21: 163-171

Dried cow manure fed to chickens in two series of experiments proved to have zero metabolizable energy content. While it had no toxic effect of the birds, its acceptability was so low that it proved to be a poor substitution even for inert pulverized rock.

1971-1155
LOEHR, Raymond C.
Alternatives for the Treatment and Disposal of Animal Wastes
WPCF Jnl. 43: 668-678
Abst: McQ & B B-087

Nine systems for handling animals wastes are presented schematically and discussed briefly. These are:

1. Water flushing → Holding tank → Land disposal.

2. Water flushing → Aerobic unit (oxidation pond, aerated lagoon, or oxidation ditch) → Land disposal.

3. Water flushing → Anaerobic unit → Aerobic unit → Land disposal.

4. In-House oxidation units (with slatted floor and rotor) → Holding unit → Land disposal.

5. In-house holding unit → Land disposal.

6. Separation at the source. Solids to land, liquids to treatment.

7. Drying.

8. Incineration.

9. Composting.

1971-1156
LOEHR, Raymond C.
Poultry Waste Management
Proc. Natl. Symp. on Animal Waste Mgmt. p. 107-110
Abst: McQ & B C-341

Droppings caught in a wet pit decompose anaerobically. When spread, they have a noxious odor and may pollute runoff. Aeration or drying followed by land disposal is feasible; treatment for disposal to water is unrealistic. Drying is feasible if a market exists for the product. Some nitrogen removal can be accomplished in an oxidation ditch. ". . . determine overall rather than piecemeal solutions."

1971-1157
LOEHR, Raymond C.
Animal Waste Management -- Problems and Potential Solutions
Proc. Agr. and Pollution Seminar, Univ. of Ariz. p. 1-17

After an introduction sketching the development of the problem of animal wastes with its social and legal constraints, LOEHR examined treatment and disposal methods. Liquid manure handling contaminates more volume of material, but eases handling problems. "The use of aerobic systems is increasing to avoid the odor problems that can occur with anaerobic holding tanks." For solid waste handling, composting -- often of a combination of manure with sawdust, corncobs, paper, or municipal refuse -- is technically feasible, but seldom financially attractive. Drying, dehydration, and incineration eliminate odors and flies and reduce the bulk to be disposed of. With inclusion of air pollution control devices, they tend to be expensive. Land disposal with holding tanks and a plow-furrow-cover or similar method of application will probably remain the usual pattern.

Waste disposal should be treated as one element in optimizing livestock production.

1971-1158
LOEHR, Raymond C.; ANDERSON, Donald F.; and ANTHONISEN, Arthur C.
An Oxidation Ditch for the Handling and Treatment of Poultry Wastes
Proc. ISLW p. 209-212
Abst: McQ & B C-272

Oxidation ditches are used in livestock waste management to prevent and control odor, save labor, and purify waste. A further advantage is the ease of incorporation in confinement housing. Tests of an oxidation ditch in a poultry house at Cornell, with the ditch stressed to the maximum to determine limiting adequacy, showed it to be a "reasonable alternative" method of handling poultry wastes. Maintenance can be expected to be minimal but necessary. The effluent should receive land disposal with proper land and crop management. No applicable cost data were obtained.

1971-1159
LUDINGTON, David C.; SOBEL, Albert T.; and GORMEL, B.
Control of Odors Through Manure Management
ASAE Trans. 14: 771-774, 780 [ASAE Paper 69-936]
Abst: McQ & B B-053

Masking, counteracting, or oxidizing manure odors after production has not been very successful. Laboratory and field tests aimed at their inhibition are described. Moisture content is closely related to odor offensiveness. Composting or aeration greatly reduces it. Daily scraping with removal of moisture or removal of manure is effective.

1971-1160
LUDINGTON, David C.; SOBEL, Albert T.; and HASHIMOTO. A. G.
Odors and Gases Liberated from Diluted and Undiluted Chicken Manure
ASAE Trans. 14: 855-859 [ASAE Paper 69-426]
Abst: McQ & B B-056, G-054

Gases produced and their intensities are compared, with strength being plotted as a function of time for many of them.

1971-1161
LUNIN, Jesse
Agricultural Pollution in Perspective
World Agric. 20: Oct. p. 13-17

"As in so many fields of human activity and endeavor, man's choice is mostly between two evils; all wisdom can often do no more than choose the lesser one."

Animal waste management problems in America are summarized briefly. Treatment by lagoons with disposal of the effluent by sprinkler irrigation on land to utilize the potential of soil for removing nutrients is advocated.

". . . expensive control measures will increase production costs; ultimately these costs will have to be absorbed by the consumer."

1971-1162
MADDEN, John M. and DORNBUSH, James N.
Measurement of Runoff and Runoff Carried Waste from Commercial Feedlots
Proc. ISLW p. 44-47
Abst: McQ & B C-224

For conditions in southeastern South Dakota measurements of runoff from six feedlots over a two-year period indicate that five percent of the total waste produced is carried to streams in surface runoff while 95 percent is removed in cleaning or decomposes in the feedlot. By means of minimal detention facilities the portion carried by runoff can be reduced to less than two percent. Data are tabulated in the paper.

1971-1163
MANGES, H. L.; SCHMID, L. A.; and MURPHY, L. S.

Land Disposal of Cattle Feedlot Wastes
Proc. ISLW p. 62-65
Abst: McQ & B C-229

After concluding that there is no profitable method of using livestock manure and, thus, that low cost methods of waste disposal were needed, the authors studied the orderly disposal of wastes onto agricultural land by the establishment of test plots at a feedlot at Pratt, Kansas, designed to accomodate 33,000 head on 220 acres.

The objectives stated were to characterize the stormwater runoff from a feedlot, to characterize the manure generated, and to determine the influence of runoff and manure loading rates on soil and water characteristics and on yield of corn. It was concluded, on the basis of the first year's tests, that "the ratio of land needed for disposal of feedlot wastes to feedlot area will be determined ultimately by the permissible accumulation of nitrogen and salts in the soil profile."

1971-1164
MATHERS, A. C. and STEWART, B. A.
Crop Production and Soil Analyses as Affected by Applications of Cattle Feedlot Waste
Proc. ISLW p. 229-231, 234
Abst: McQ & B C-277

Some tests in the Texas Panhandle demonstrated that when nitrogen in excess of crop needs is applied to land, nitrate will accumulate and move downward in the soil profile. Accumulation of nitrate in crops used for silage could be a health hazard for livestock. Excess nitrate lowers the sugar content in beets.

"Pollution hazards of using animal wastes on cropland are eliminated only when the crop uses most of the nitrogen."

1971-1165
McCALLA, T. M. and ELLIOTT, L. F.
The Role of Microorganisms in the Management of Animal Wastes on Beef Cattle Feedlots
Proc. ISLW p. 132-134
Abst: McQ & B C-249

"Laboratory studies at Lincoln and feedlot studies at Central City, Nebraska, indicate mechanical removal of manure from the feedlot may be necessary only after several years of accumulation. The manure in the feedlot can be mounded to provide a protected, drained area for the animals, and the manure serves as a compost pile to aid in decomposition. This paper discusses some of the microbial decomposition alternatives of animal waste from a feedlot-management standpoint."

"As long as the soil-organic matter interface is not disturbed, such as by cleaning, NO_3-N will not move to the water table. Prolonged drought periods or absence of animals could also disrupt this so-called 'seal'."

Twenty-eight references are cited.

1971-1166
McCASKEY, T. A.; ROLLINS, G. H.; and LITTLE, J. A.
Water Quality of Runoff From Grassland Applied with Liquid, Semi-Liquid, and 'Dry' Dairy Waste
Proc. ISLW p. 239-242
Abst: McQ & B C-280

Test plots in Alabama with 3.3 percent slopes and good covers of bermuda grass were applied with liquid waste from a holding tank, liquid waste spread by a tank wagon, and waste as voided applied by a conventional manure spreader. Precipitation during the study period (8 Dec '69 to 15 Dec '70) was 52.3 inches.

The liquid manure spread at rates up to 0.96 tons (dry basis) per acre once each three weeks caused no problems. Dry manure spread at a rate of 3.2 tons per acre each three weeks resulted in a marked accumulation of solids. High rates of application are not recommended unless a cropping system is used.

1971-1167
McCLURE, K. E.; VANCE, R. D.; KLOSTERMAN, E. W.; and PRESTON, R. L.
Digestibility of Feces from Cattle Fed Finishing Rations (Abst)
Jnl. Animal Sci. 33: 292
Abst: McQ & B B-239

Mean digestibility of dried corn alone and of dried corn with corn silage fed to cattle was 85 and 77 percent. The corresponding crude proteins were 80 and 74 percent respectively. Sheep rations containing 45 percent cattle feces from the corn and corn-and-silage fed cattle in various combinations had mean digestibilities of 52.4 to 60.9 percent. Mean digestibilities of the sheep feces showed a further decrease.

1971-1168
McGILL, H. N.
Management of Runoff Water in Relation to Feedlot Operations
Soil Conservation Service - Texas Tech Workshop. Lubbock. 28-29 July. 13 p.

Accepted practice for cattle feedlots in Texas is to divert inflow around the lot and to intercept and impound runoff from the lot. The impounded water may be used for irrigation. Elimination of effluent rather than treatment of it is the goal. The author presents a reservoir operation study, citing sources of data for Texas, for such irrigation. Feelot runoff is not a dependable source of irrigation water.

1971-1169
MEINHARDT, Paul
Cattle as an Economic Base for an Ecological Loop
Feedstuffs 43: 3 July p. 18, 20

Among the conclusions stated are the following: "1. Utilizing only organic wastes and marginal land, it may now be feasible to produce an abundance of beef without using human foodstuffs -- the nature of the ruminant stomach, the genetic flexibility of cattle, and the worldwide acceptance of beef make this possible.

"2. Beef may be produced on a large scale, at less than 5 ¢ per pound, by locating dry-lot breeding facilities and feedlots in and around cities -- at urban fringes and in city dumps -- even the manure becomes a valuable resource for refeeding, fertilizing, or producing electricity -- a major source of economies are (1) close proximity for all production inputs to minimize transport costs; (2) nearness to cheap feeds (garbage); and (3) the production of beef close to urban markets using devalued land.

"3. Sufficient organic waste exists in most countries to feed an abundance of beef -- waste vegetation, industry wastes, paper, manure, and even sewage, when properly fed and supplemented, can feed beef."

1971-1170
MELVIN, Stewart W.
How to Comply with Iowa's Feedlot Runoff Control Regulations
Iowa State Univ. Coop. Ext. Serv. Pm-511 4 p.
Abst: McQ & B E-236

Requirements of the law on feedlot control are quoted and answers to questions of interpretation are given. In particular, for an acceptable runoff system: 1. Prevent inflow to the lot by locating near a topographic ridge and/or constructing diversion channels or dykes. South to east slopes are preferred since they are warmer and they dry faster. 2. Divert all roof drainage away from the feedlot surface. 3. Surround the feedlot with dykes to control runoff and prevent inflow. 4. Provide a settling channel or terrace; remove the deposited solids during dry periods in summer. 5. Catch the liquid runoff in a pond with sufficient volume to permit of disposal by irrigation.

1971-1171
MESSER, James W.; LOVETT, Joseph; MURTHY, G. K.; WEHBY, A. J.;
SCHAFER, Mary L.; and READ, R. B., Jr.
An Assessment of Some Public Health Problems Resulting from Feeding
Poultry Litter to Animals. Microbiological and Chemical Parameters
Poultry Sci. 50: 874-881
Abst: McQ & B B-297

Summary by authors: "The feeding of poultry litter to cattle, sheep, and swine has opened many questions of public health significance. The present study was designed to examine (1) whether the heat resistance of Salmonella and Arizona pathogens in poultry litter was similar to that expected for wet or dry heat, (2) whether heat treatment of poultry litter would provide an effective barrier against disease transmission, and (3) to determine levels of some medicinals, pesticides, and ultraviolet-light-activated compounds in poultry litter.

"Results demonstrated that salmonella and *Arizona Sp.* are not highly resistant to heat in poultry litter of normal moisture content. Thus a heat process for their elimination may be feasible. The fact that salmonellae are more resistant to moist heat, however, than are *E. Coli* eliminates the use of *E. Coli* as an indicator of the efficiency of the heating process.

"With the exception of arsenic, the concentration of pesticides and medicinals present in the litters assayed in this study were low. It is possible that levels higher than those reported here might be present in poultry litter. This possibility and the unknown effect of continuous exposure to low levels of pesticides and medicinals suggest that the present ban on the interstate shipment of poultry litter for animal feed is warranted."

1971-1172
MILLER, Byron F.
Biological Conversion of Animal Wastes to Nutrients
EPA Pbln. SW-5r.2, p. 73-74

Fly pupae convert "wet, pasty, odiferous" poultry manure into an inoffensive, granular product which retains most of the fertilizer value of the manure. The dried fly pupae contain sixty percent protein and furnish vitamins and minerals when used in a chick diet. An optimum crop of pupae has a weight of about two percent that of the fresh manure.

1971-1173
MILLER, Byron F.
Biological Conversion of Animal Wastes to Nutrients

Final Rpt. Proj. EC-00262-02, Dept. of Avian Science, Colo. St. Univ.
xi + 69 p.
Abst: Compost Sci. 13: Mar-Apr. '72 p. 2

Fly eggs were placed in fresh poultry manure at a number of different concentrations, different temperatures, and different humidities in a series of experiments at Colorado State University. Optimum production of pupae occurred with three g of fly eggs in 4000 g of manure at 27°C and 41 percent relative humidity. At two g eggs per 4000 g manure, the larvae were significantly heavier.

Three feeding trials in which dried pupae and/or catabolized poultry manure residue were used as protein components to replace soybean meal and/or milo in chick starter diets are reported in detail. The dried pupae gave results which did not differ significantly from those of the soybean meal. The digested poultry manure was significantly less desirable than the controls.

1971-1174
MILLER, William D.
Subsurface Distribution of Nitrates Below Commercial Cattle Feedlots,
Texas High Plains
Water Res. Bull. 7: 941-950

Core sampling under 80 commercial cattle feedlots ranging in age from new to 35 years established that "infiltration of feedlot liquid waste to the water table below feedyards is insignificant in most localities in the Texas High Plains. . . Certainly, no regional subsurface pollution problem exists today nor is one foreseen from cattle feedlot runoff in the Texas High Plains."

1971-1175
MILLER, William D.
Infiltration Rates and Groundwater Quality Beneath Cattle Feedlots,
Texas High Plains
EPA Water Poll. Control Rsch. Series 16060 EGS. viii + 55 p.

A test drilling program under and near a number of cattle feedlots on the Texas High Plains established that while concentrations of ammoniacal, organic and nitrite nitrogens in feedlot runoff exceed those in the groundwater of the Ogallala aquifer, the nitrate nitrogen in the runoff may often be less concentrated. Infiltration varies with soil texture; the bottoms of playa lakes may present an effective barrier against contamination of groundwater. Permeability is often so low that feedlot effluent reaching the water table is returned by wells close to the feedlot. "No regional degradation of the Ogallala groundwater is expected in the foreseeable future, only degradation in specific localized areas."

1971-1176
MILLER, William D.
Effect of Cattle Feedlot Wastes Upon Ground Water -- A Commentary
Soil Conservation Service - Texas Tech Workshop. Lubbock. 28-29 July.
5 p.

Many potential pollutants are present in feedlots wastes. By having proper regard for surface topography, soil permeability, bedrock characteristics, and depth to groundwater in locating feedlots, their actual effect can be minimized.

1971-1177
MINER, J. Ronald
Livestock Wastes [In a Review of the 1970 Literature on Wastewater and Water Pollution Control.]
WPCF Jnl. 43: 991-998
Abst: McQ & B B-085

In general, a sentence or two was devoted to each of the 60 references listed. Subheadings within the narrative were: waste characteristics, waste treatment studies, manure-handling systems, manure gases and odors, application of wastes to cropland, and cattle feedlot wastes.

1971-1178
MINER, J. Ronald
A Recirculating Waste System for Swine Units
EPA Pbln. SW-5r.2, p. 30-31

A system performing well under test consists of a swine confinement building from which manure and water flow by gravity to an anaerobic lagoon, and an oxidation ditch to which lagoon effluent is pumped. Effluent from the oxidation ditch is pumped to the confinement building for use in flushing. Future modifications and irrigation practices are discussed.

1971-1179
MINER, J. Ronald
Farm Animal-Waste Management
Iowa Ag. Ex. Sta. Spl. Rpt. 67. May. 44 p.
Abst: McQ & B E-088

This state-of-the-art review provides a background in the biology, biochemistry, and chemistry of animal wastes then considers aerobic treatment in oxidation ditches, oxidation ponds, and aerobic lagoons. Anaerobic lagoons, heated anaerobic digesters, and combined anaerobic-aerobic systems are next considered. Utilization of farm animal wastes for fertilizer is discussed. Refeeding, composting, incineration, dehydration, and use of hydroponics -- none widely employed at present -- are introduced and predictions for the near, foreseeable, and distant future are ventured.

1971-1180
MINER, J. Ronald; WOOTEN, J. W.; and DODD, J. D.
Water Hyacinths to Further Treat Anaerobic Lagoon Effluent
Proc. ISLW p. 170-173
Abst: McQ & B C-259

Water hyacinths were successfully grown in Iowa in the summer in dilute effluent from an anaerobic lagoon treating swine manure. Evapotranspiration was 3.2 to 3.7 times that from a free water surface. A production of 84 tons/acre (5 tons/acre dried weight) removed 500 lb/acre of nitrogen, 82 percent of influent phosphorus, and 88 percent of influent COD. The effluent was suitable for discharge to many streams and could be used on porous ground without difficulty from nitrogen build-up in groundwater.

"The economic feasibility and attractiveness of this system demands that uses for the harvested plants be devised. Limited use has been made of the plants as livestock roughage, although data are insufficient to establish this as an economical practice."

1971-1181
MOODY, Wendell B.
Seepage Loss from Holding Ponds
Soil Conservation Service - Texas Tech Workshop. Lubbock. 28-29 July.
34 p.

Detailed calculations are given for a typical analysis of seepage losses from a proposed pond. Such losses may be estimated following an investigation of soil and bedrock characteristics and laboratory testing of the soils. Construction and protection of relatively impervious blankets are discussed.

1971-1182
MORRIS, W. H. M.
Economics of Waste Disposal from Confined Livestock
Proc. ISLW p. 195-196, 198
Abst: McQ & B C-267

"The costs of waste disposal, while significant, are not driving farmers out of livestock production." Values of fertilizer, based on the constituents N, P, and K, declined from 7.0, 8.0, and 4.2 ¢/lb respectively in 1966 to 4.5, 8.0, and 3.6 ¢/lb in 1971. Calculated fertilizer values per ton of liquid manure ranged from 18-40 ¢/ton for cow manure to $2.18-$2.73 per ton for poultry cage layers in 1971. The costs of storing manure and of operating oxidation ditches are analyzed. Dehydration is estimated to cost $1-$3 per ton. Conventional municipal treatment would cost $100 to 200 in capital costs and $4-$7 per year for operating costs per head.

"Values of manure as a feed far exceed its value in any other use and make it about as valuable as some of the better roughages."

1971-1183
MORRISON, S. R.; LOFGREEN, G. P.; and BOND, T. E.
Feedlot Manure Management in a Desert Climate
Proc. ISLW p. 60, 61, 65
Abst: McQ & B C-228

Feedlots in desert conditions are less subject to runoff with resulting stream pollution. "The aim is no outflow, no seepage to groundwater, and minimum sludge to dispose of, besides avoiding nuisance to nearby dwellers."

For the conditions at the Imperial Valley Field Station (2-3 in. annual rainfall, over 100 in. potential evaporation) the authors concluded that about "60 percent of the organic matter (volatile solids) and 45 percent of the nitrogen was removed by an anaerobic-aerobic manure treatment system at a loading rate of 0.023 lb organic matter per day per cu ft. A liquid surface of about 200 sq ft was sufficient to evaporate the water in the waste from four beef animals. Investigations of manure movement, other aeration systems, and sludge handling are necessary for further development of a satisfactory manure management system for a desert climate." Eight references are listed.

1971-1184
MUEHLING, Arthur J.
Swine Waste Management
Proc. Natl. Symp. on Animal Waste Mgmt. p. 111-119
Abst: McQ & B C-342

It is not feasible to treat swine wastes for release to streams. Spreading is resorted to more for disposal than for fertilizer value. Systems of waste handling currently employed are:

1. Wastes from hogs on pasture (may be serious source of pollution),

2. Handling solids (some bedding is required and dilution must be minimized),

3. Slotted floors -- store and haul (should be incorporated in soil upon spreading to reduce odors and runoff),

4. Waste lagoons,

5. Combination of hauling and lagoon,

6. Oxidation ditch, and

7. Hydraulic manure removal.

Dehydration, incineration, and composting appear to hold little promise for swine manure. Refeeding may prove to be worthwhile.

1971-1185
NGODDY, Patrick O.; HARPER, Jerome P.; COLLINS, Robert K.; WELLS,
Grant D.; and HEIDAR, Farouk A.
Closed System Waste Management for Livestock
EPA Water Poll. Control Rsch Ser. 13040 DKP 110 p.
Abst: McQ & B E-087

If the wastewater from livestock be separated by means of a vibrating screen the liquid portion responds much better to a biological treatment. The solid portion consists of odorless, stable material which can be stored for long periods without an odor-nuisance or risk of pollution. Programs for design and operations of waste handling facilities involving screens are developed.

1971-1186
NORDSTEDT, R. A.; BALDWIN, L. B.; and HORTENSTINE, C. C.
Multistage Lagoon Systems for Treatment of Dairy Farm Wastes
Proc. ISLW p. 77-80
Abst: McQ & B C-233

Most lagoons reported upon have a low input volume and long retention period. Few are in warm climates with sandy soil and a high water table. Since the wastewater from a typical Florida dairy has a solids content of less than 0.4 percent and a BOD of 500-1000 ppm, lagoons have been discouraged. The paper reports on the first eight months of a trial with an anaerobic lagoon followed by two aerobic lagoons and ultimate disposal for pasture irrigation. Results have shown seasonal trends but appear promising. Data are tabulated.

1971-1187
NORDSTEDT, R. A.; BARRE, H. J.; and TAIGANIDES, E. Paul
A Computer Model for Storage and Land Disposal of Animal Wastes
Proc. ISLW p. 30-33
Abst: McQ & B C-220

A dynamic programming model for optimizing operation of a land disposal system considering land availability, storage capacity, value of plant nutrients in the waste, costs of labor, capital and operation costs, etc. is described.

1971-1188
NORDSTEDT, R. A. and TAIGANIDES, E. Paul
Meteorological Control of Malodors from Land Spreading of Livestock Wastes
Proc. ISLW p. 107-109, 116
Abst: McQ & B C-242

Odors are less detectable if less manure is spread and if wind velocities are high. It would be prudent to study weather forecasts before spreading in proximity to population concentrations.

Mathematical equations with incompletely defined parameters and computer programs have been developed to aid in estimating possible odor nuisances.

1971-1189
NYE, John C.; DALE, Alvin C.; and BLOODGOOD, Don E.
Effect of Temperature on Aerobic Decomposition of Dairy Cattle Manure
ASAE Trans. 14: 545-548 [ASAE Paper 69-926]
Abst: McQ & B B-051, G-068

Laboratory studies on semi-continuous and batch feedings of manure to aerobic chambers are described. In all cases, oxygen must be supplied, in addition to any natural aeration which may occur, to maintain aerobic conditions. With 74 days' storage above 65°F, a 70 percent reduction in COD resulted. With the same period below 48°F, the reduction was 45 percent.

1971-1190
OGILVIE, John R. and DALE, Alvin C.
Short Term Aeration of Dairy Cattle Manure for Irrigation
Proc. ISLW p. 283-285, 287
Abst: McQ & B C-292

Aeration for less than 24 hours may be effective in rendering manure relatively odorless. Field and laboratory studies are reported in which success was obtained with diluted dairy cattle manure. An additional aerated lagoon is recommended for areas subject to winter freezing.

"The oxidation ditch, a continuous flow method of treatment, detains the animal manure for very long times with the object of degrading much of the solids. We suggest that these solids could be just as easily degraded on or in the soil without the input of electrical energy."

1971-1191
OKEY, Robert W. and BALAKRISHNAN, S.
The Economics of Swine Waste Disposal
Proc. ISLW p. 199-203
Abst: McQ & B C-269

Seven procedures are considered for swine waste disposal: ground disposal, lagoon storage (anaerobic treatment), total oxidative treatment, organic solids separation and treatment of the liquid stream, various of the preceding with nitrogen and/or phosphate removal, and various of the preceding with dissolved solids removal. The chemical methodologies are discussed and costs are tabulated for systems of 500, 2000, and 5000 swine.

Treatment may be a negative item in cost accounting and still effect an overall saving. Twenty-six references are listed.

1971-1192
OREGON STATE BOARD OF HEALTH
Agricultural Solid Waste Study
Oregon State Board of Health 90 p.

Present methods of animal manure management include land disposal, anaerobic lagoons, and oxidation ditches. The advantages and disadvantages of each are presented briefly. [p. 17-22].

Alternative methods, considered to be financially or otherwise unsuited for conditions in Oregon, are incineration, dehydration, plow-furrow-cover, and use of manure treatment plants. [p. 28-29].

Methods involving recycling and reuse are composting (very limited usage in Oregon), separation of liquids and solids by dilution followed by filtering (costly, odorous, source of mosquito breeding), aerobic algae ponds (experimental to date, but very encouraging), refeeding manure (profitable but with potential for disease transmission), and digestion by diptera (problems with harvesting pupae and/or adult flies). [p. 32-37].

Environmental effects of animal wastes are explored. Flies, mosquitoes, rodents, and air and water pollution must be prevented.

1971-1193
ORR, D. E.

Recycling Dried Waste to Finishing Pigs
Mich. Ag. Ex. Sta. Rsch. Rpt. 148 p. 63-68

Performance of several groups of pigs on corn-soybean meal rations with various percentages of the ration replaced by dried swine feces (DSF) or dried poultry wastes (DPW) is discussed and tabulated. Among the conclusions stated are that pigs will consume corn-soy rations containing up to 22 percent of DSF at 90 to 95 percent of full appetite, that rate and efficiency of gain are depressed if DSF replaces all or most of the soybean meal, that incorporation of DSF in the ration does not affect the flavor of the meat, and that DPW is of somewhat less value in swine rations because it is low in critical amino acids and high in calcium.

1971-1194
ORR, D. E.; MILLER, E. R.; KU, P. K.; BERGEN, W. G.; and ULLREY, D. E.
Recycling of Dried Waste in Swine (Abst)
Jnl. Animal Sci. 33: 1152
Abst: McQ & B B-244

In tests in which dried swine feces (DSF), which contain 21.6 percent crude protein, were substituted for various constituents of the ration, daily gain and feed-to-gain ratios were poor. ". . . availability of several amino acids may have limited performance on DSF." No detectable taste difference appeared in the roast loins.

1971-1195
OSTRANDER, Charles E.
Poultry Waste Handling Systems
Poultry Digest 30: 529-532

The relative merits of deep pit, aerobic lagoon, oxidation ditch, soil injection, and dehydration are discussed. Each has its place. To prevent odor, keep manure dry or keep it aerobic. Design criteria for aerobic lagoons and for oxidation ditches are given.

Dehydration involves capital outlay and some odor. The final product has a limited market as a soil conditioner. "At the present time it is not legal to sell this as feedstuff. . . The feed value is much greater if fed to ruminants which can utilize the uric acid to better advantage." The optimum ration appears to be about ten percent DPW.

1971-1196
OSTRANDER, Charles E.
Soil Injection for Manure Disposal
Cornell Poultry Pointers Dec.
Reprint: Poultry Digest 31: 79 (1972)

Injection reduces or eliminates odors. It reduces loss of nutrients by runoff or by evaporation, thus simultaneously reducing water or air pollution. Equipment should be carefully selected. Under ideal conditions the process can be faster than spreading.

(See also a note: "Equipment for Soil Injection of Manure," based on OSTRANDER, in Poultry Digest 31: 548).

1971-1197
OSTRANDER, Charles E.
Oxidation Ditches Under Cages Eliminate Manure Odors and Flies
Poultry Tribune 77: Mar. p. 72, 74

Oxidation ditches, while not foolproof, "can eliminate practically all the objections that have been raised about the liquid system of manure handling. 1. Odors in houses -- eliminated; 2. Odors from fans -- eliminated; 3. Odors at spreading time -- eliminated; 4. Volume of material to handle -- no increase and perhaps decreased." Spread oxidation ditch residue should be covered promptly. The ditches must be competently designed.

1971-1198
OSTRANDER, Charles E. and LOEHR, Raymond C.
Handling Poultry Wastes with an Oxidation Ditch (Abst)
Poultry Sci. 50: 1613
Abst: McO & B B-301

An oxidation ditch under 250 layers operated effectively on a nine-month run before being stopped, at nine percent solids content, for cleaning. Some foaming and odor occurred during the first month.

1971-1199
OSWALD, William J.
Photosynthetic Reclamation of Agricultural Solid and Liquid Wastes
EPA Pbln. SW-5r.2, p. 85-86

In a pilot plant at Richmond, California, the wastes from a hen house were fermented in an anaerobic digestion tank with the effluent feeding directly into an algae pond. Water from the pond was used for flushing in the hen house, and the algae were fed to the hens. The pond was aerated during the winter. Algae production was 30 to 40 tons (dry wt) per acre of pond. "The net waste-handling cost would be one cent or less per dozen eggs."

1971-1200
OUSTERHOUT, L. E. and PRESSER, Robert H.
Increased Feces Production from Hens Being Fed Poultry Manure (Abst)

Poultry Sci. 50: 1614
Abst: McQ & B B-302

A control group of chickens fed a standard ration, a second group fed the standard ration plus their feces of the previous day, and a third group fed the standard ration plus the feces of the control group and of the third group were investigated. "Egg production was normal for group 2 for 8 days and for group 3 for 3 days, after which it fell drastically."

"This and other related studies indicate recycling manure reduces the disposal problem by no more than 25% with no noticeable further reduction with repeated recycling."

1971-1201
OVERMAN, A. R.; HORTENSTINE, C. C.; and WING, J. M.
Growth Response of Plants Under Sprinkler Irrigation With Dairy Waste
Proc. ISLW p. 334-337
Abst: McQ & B C-307

Response at different times of year to various rates of application of washwater with a solids concentration of 0.25 percent (20,000 gal from 150 cows) to crops in Florida is reported.

Concentration of nutrients (N, P, K, and soluble salts) in the soil water at a depth of 60 cm increased as the rate of irrigation application increased. Utilization by a crop may best be evaluated by reference to yield response curves.

"Oats grown with dairy manure measure up to those grown with inorganic fertilizer in chemical composition, palatability and digestibility."

1971-1202
PARKER, John
Feeders and Feedlots
Western Livestock Jnl. 49: June p. 65

Legally, confusion reigns in the feedlot industry. Court decisions on nuisance charges appear unrelated to compliance with state pollution codes.

1971-1203
PATRICK, Tom
Waste Disposal: Will It Price You Out of Business?
Big Farmer 43: Sept. 2 p.

Net costs of animal waste disposal for the Southern High Plains are stated to be $15.17 per head marketed despite nutrient values of $3.61 per ton. Methods of disposal cited are dehydration to produce marketable fertilizer, drying and recycling of poultry wastes, composting, and irrigation with liquid wastes.

1971-1204
PEREZ-ALEMAN, S.; DEMPSTER, D. G.; ENGLISH, P. R.; and TOPPS, J. H.
A Note on Dried Poultry Manure in the Diet of the Growing Pig
Anim. Prod. 13: 361-364
Abst: McQ & B B-320

Trials in Aberdeen, Scotland, with 10, 20, and 30 percent sterilized dried poultry wastes in the diets of growing pigs had no adverse effect on the pigs health or carcass quality. "For every 10% addition of manure, growth was reduced by 0.02 kg/day, feed conversion efficiency by 0.25 units and killing-out percentage by 0.96. The dried manure contained about 30% crude protein and was a rich source of minerals."

1971-1205
PETERSON, Mirzda L.
Parasitological Examination of Compost
EPA Office of Research and Monitoring, Solid Waste Research Open-File
Report 15 p.

The literature on health hazards in composted sewage sludge and municipal solid wastes is reviewed. Viable parasites have been found in marketed compost. Means of recovering animal parasites and ova in the laboratory are discussed. ". . . compost. . . from animal excreta has the potential hazard of a residual pathogen content."

1971-1206
PFEFFER, John T.
Reclamation of Energy from Organic Refuse
EPA Pbln. SW-5r.2, p. 88-89

A laboratory investigation is being undertaken "to determine the operating parameters for the biologic conversion of organic solid waste to methane by use of anaerobic digesters."

1971-1207
PITTMAN, Dwight L.
Guidelines for Handling Liquid Waste from Feedlots
Soil Conservation Service - Texas Tech Workshop. Lubbock. 28-29 July.
4 p.

Present (July, 1971), and a proposed modified, procedure for securing a "Waste Control Order for Cattle Feeding Operation" from the Texas Water Quality Board is described. Means of protecting surface and groundwater to include the runoff from maximum probable 24-hr rain in 25 years must be provided. Means of disposal of solid wastes must be acceptable. Pond seepage should be restricted to 0.1 ac-ft/ac-yr, and equipment should be available to dewater the pond within fourteen days without runoff occurring from the disposal area.

1971-1208
POLIN, D.; VARGHESE, S.; NEFF, M.; GOMEZ, M.; FLEGAL, Cal J.;
and ZINDEL, Howard C.
The Metabolizable Energy Value of Dried Poultry Waste
Mich. State Univ. Ag. Ex. Sta. Rsch. Rpt. 152 p. 32-44
Abst: McQ & B E-210

Dried poultry waste has a low energy content and thus cannot be substituted pound-for-pound for corn. Its contribution of calcium is greater than that of corn, and both feeds supply about the same amount of protein. Neither interferes with utilization of fat in the ration. Results of feeding tests and feed compositions are tabulated.

1971-1209
POS, Jack; BELL, R. G.; and ROBINSON, J. B.
Aerobic Treatment of Liquid and Solid Poultry Manure
Proc. ISLW p. 220-224
Abst: McQ & B C-275

Aeration can effect odor control with quantities of air well below those required for stabilization. Both odor control and stabilization may be accomplished by composting.

A series of studies at Guelph, Ontario, on the effects of aeration on liquid and on solid chicken manure, in pilot and field tests, is reported. Under Canadian winter conditions mechanical devices are inadequate to produce aeration. The use of pneumatic devices might be effective. Composting could be practical year round.

1971-1210
PRATT, Parker F.
Water Pollution from Disposal of Dairy Manure on Land in Relation to
Soil Management and Site Characteristics
Univ. of Cal. Water Resources Center Ann. Rpt. Rpt. No. 23, p. 127-129

WRC Project 267, funded 1969-72, is a continuing investigation of possible groundwater contamination by nitrates in the Chino-Corona basin in which only 12,500 acres are available for the disposal of manure from 125,000 dairy cows. Total nitrogen in lb/acre reported are: corral 1938, pasture 670, and cropland 727. Concentrations in ppm at 10- to 19-ft depths (below root zone) are corral 92, pasture 74, and cropland 66. The full impact has not yet reached the watertable.

1971-1211
PUTNAM, Paul A.
Feedlot "Waste" for Feed
CALF News 9: May p. 14-15

The Agricultural Research Service at Beltsville, Maryland, has fed beef feedlot manure, subjected to various treatments, to sheep in amounts up to 85 percent of the ration with no apparent ill effects. Investigations continue.

1971-1212
REDDELL, Donald L.; JOHNSON, W. H.; LYERLY, P. J.; and HOBGOOD, Price
Disposal of Beef Manure by Deep Plowing
Proc. ISLW p. 235-238
Abst: McQ & B C-279

Manure was disposed of by deep plowing at rates of 0, 300, 600, and 900 tons per acre, wet weight, on experimental plots. With a moisture content of about 50 percent the corresponding manure depths were about 0, 3, 6, and 9 inches. The equipment is described and costs are tabulated. "The water quality program shows no serious pollution problem for surface water runoff. Although inhibited, crop growth on all manure treatments has been achieved."

1971-1213
REPUBLIC OF SOUTH AFRICA
Water Amendment Act, 1971 (Act No. 36, 1971)
Government Gazette, Vol. 71, No. 3106

Section 3 of this act, designated to become section 23A of the Water Act, 1956 (South Africa's basic comprehensive water law), empowers the Minister of Water Affairs to prevent the pollution of water through farming operations. The Minister may require that "such steps as the Minister may deem necessary for the prevention of such pollution" be taken. In case of lack of compliance, the Minister may cause the steps to be taken and may recover the costs from the owner.

1971-1214
RICHTER, Jay

Registration is Required as Gov't Moves to Control Water Pollution From
Large Feedlots
Beef 7: July p. 20

Registration is now required for feedlots of over 1000-head capacity under most circumstances. The turn of the smaller lots is coming.

1971-1215
ROBBINS, Jackie W. D.; GEORGE, Robert M.; McNABB, Coy G.; and GARNER, George B.
Helping Farmers Produce -- Not Pollute
Agr. Engrg. 52: 258-259
Abst: McQ & B B-648

The University of Missouri - Columbia has "initiated pilot studies to harvest algae from animal wastewaters using organic filter material and to dispose of liquified animal wastes by subirrigation. . . Studies will be developed to modify the wastes produced by animals by controlling their environments and rations, particularly the temperature of the environments and the salt content of the rations."

1971-1216
ROBBINS, Jackie W. D.; HOWELLS, David H.; and KRIZ, George J.
Role of Animal Wastes in Agricultural Land Runoff
EPA Water Poll. Control Rsch. Series 13020 DGX x + 114 p.
Abst: McQ & B E-086

"The natural pollution load on streams draining agricultural basins free of farm animals can be appreciable during periods of rainfall and runoff and should be taken into consideration in water quality management." Land spreading is an effective means of preventing pollution; it should be combined with good soil and water conservation practices. Anaerobic lagoons are unsatisfactory as a sole means of treatment in areas where rainfall exceeds evaporation.

Criteria tentatively recommended for land disposal practices include: a) apply wastes uniformly; b) govern rate, time, and frequency of application for maximum nutrient utilization by plants; c) select disposal areas with low erosion potentials; d) do not apply waste on grassed waterways or other drainage paths; and e) plow waste under on barren fields.

1971-1217
ROBBINS, Jackie W. D.; KRIZ, George J.; and HOWELLS, David H.
Quality of Effluent from Farm Animal Production Sites
Proc. ISLW p. 166-169, 173
Abst: McQ & B C-258

"This report summarizes the findings of a two-year study undertaken to investigate the importance of animal wastes in agricultural land runoff" from twelve typical agricultural sites in North Carolina.

The natural pollution from land free of animal wastes can be appreciable. The soil provides natural treatment for animal wastes; thus, land spreading can be effective in pollution abatement, especially if precautions with respect to drainage are observed. Anaerobic lagoons were unsatisfactory as a sole treatment in that "the lagoons functioned mainly as traps, i. e., settling and retention basins, and provided only a limited amount of treatment beyond that experienced through sedimentation." Effluents from the lagoons were potent.

In general, the state of the art was found to be primitive.

1971-1218
ROBINSON, K.; SAXON, J. R.; and BAXTER, S. H.
Microbiological Aspects of Aerobically Treated Swine Wastes
Proc. ISLW p. 225-228
Abst: McQ & B C-276

The authors describe laboratory and field facilities and the experimental program on swine waste treatment at the School of Agriculture, Aberdeen, Scotland. Pig feces have some non-biodegradable components. Copper in the mineral supplements in pigs' diets may prove detrimental to biological treatment.

"Experience has shown that it is possible to produce a biologically stable effluent, occasionally with a satisfactory BOD, and a clean, odorless residual solid. Further work in needed to show how the process of purification can be improved and more clearly understood."

1971-1219
ROSS, I. J.; BEGIN, J. J.; and MIDDEN, T. M.
Dewatering Poultry Manure by Centrifugation
Proc. ISLW p. 348-350
Abst: McQ & B C-311

Poultry manure as excreted contains about 25 percent solids. Various methods of sludge concentration may be used. In particular, centrifugation with a force of 10,000 G (G being the force of gravity at sea level) will remove all wash water and recover over 95 percent of the initial solids. The quantity of water remaining to be removed by drying is thus reduced significantly.

1971-1220
SCAIFE, M. A.
The Long-term Effects of Fertilizers, Farmyard Manure and Leys at
Mwanhala, Western Tanzania
East Afr. Agr. and Forestry Jnl. 37: 8-14

In an eight-year testing program the response of maize to farmyard manure was small or negative the first year, but it increased each year. Production was limited by rainfall rather than by fertility. Groundnuts were much less responsive than maize.

1971-1221
SCHOLZ, H. G.
Systems for the Dehydration of Livestock Wastes: A Technical and
Economical Review
Proc. ISLW p. 27-29
Abst: McQ & B C-219

Reporting on three years of operation of a plant in Germany, the author concludes that the returns from the sale of dried manure may exceed the cost of dehydration. The end product is a powdery, humus-like material used by florists, vineyardists, and home gardeners. Prices are too high for most crop applications.

The essential components of the drying plant are a rotary kiln, a ventilator, and a cyclone. Through careful reuse of waste heat and recycling of flue gas precipitates the efficiency can be improved significantly. A properly designed and operated plant releases no offensive odors.

1971-1222
SCHULTE, Dennis D. and LOEHR, Raymond C.
Analysis of Duck Farm Waste Treatment Systems
Proc. ISLW p. 73-76, 80
Abst: McQ & B C-232

Some seven million ducks per year are raised on 35 farms on eastern Long Island. Most of their 6-to-7 week life is spent on water which is then treated in aerated lagoons, chlorinated, and released to be used for recreation and for shellfish habitat. The phosphorus content being excessive, a study was made to find a procedure which would minimize total treatment costs while meeting New York effluent quality standards. Operating costs, particularly chemicals and sludge disposal, were found to be the most significant expenditures. "Reduction of water usage by duck farms may be the most direct method of reducing costs."

1971-1223
SCHWIESOW, William F.
State Regulations Pertaining to Livestock Feedlot Design and Management
Proc. Natl. Symp. on Animal Waste Mgmt. p. 19-25
Abst: McQ & B E-074

This survey, based on USDA Publication ARS 42-189, gives a brief state-by-state survey of the status of legislation and/or regulations. An appendix lists changes reported by 14 September '71.

1971-1224
SCOTT, Milton L.
Poultry Waste as a Feed
Egg Industry 4: June p. 61-62

The major organic substances in poultry manure are listed under the headings "Derived from undigested food" and "Derived from metabolism." Only about fifteen percent of feed is undigested and a second use by chickens is unlikely to salvage much. Vitamins B and K are produced, but are available from other sources at little cost. Uric acid contains nitrogen, but it is in a form which poultry cannot use. Poultry waste is considered to be poor poultry feed. Ruminants can utilize the uric acid, however, and thus may profit from poultry wastes as a feed ingredient.

1971-1225
SEWELL, John I.
Agitation in Liquid Manure Tanks
Proc. ISLW p. 135-137
Abst: McQ & B C-250

"Liquid manure is a suspension of solids in water. To maintain the suspension and allow the manure to be augered, pumped, or vacuumed as a fluid; agitation is necessary. Insufficient information about optimal agitation conditions and procedures is available on which to base designs for liquid manure holding tanks. This report describes work done under University of Tennessee Agricultural Experiment Station Project H-277, 'Farm Waste Disposal'."

Theoretical studies by dimensional analysis, model studies and field investigations were pursued. Few problems were encountered. For best results exclude waste hay, silage, twine, wood chips, and rocks; add water to the tank immediately after emptying; and consider the use of baffles.

1971-1226
SHEPPARD, C. C.; FLEGAL, Cal J.; DORN, D.; and DALE, J. L.

The Relationship of Drying Temperature to Total Crude Protein in
Dried Poultry Waste
Mich. State Univ. Ag. Ex. Sta. Rsch. Rpt. 152 p. 12-16
Abst: McQ & B E-207

Statistical procedures applied to measurements of total protein percentage (Y) as a function of temperature of drying in °F (X) yielded the equation

$$Y = 31.7 + [-0.00937 (X - 509)].$$

1971-1227
SINISE, Jerry
Feedlot Cattle on Concrete
Western Livestock Jnl. 49: Sept. p. 73, 75, 76

Morales Feed Yard near Devine, Texas, has laid nearly 20 acres of four-inch thick concrete. Manure is recycled through underground sewer lines to sprinkler systems irrigating 500 acres of Coastal Bermuda. The 30-inch main is 10,000 ft long. Fifty tons per acre per year are spread. Pens are cleaned every two weeks.

1971-1228
SMITH, L. W.
Feeding Value of Animal Wastes
USDA ARS 44-224 p. 5-13

This paper, an excellent survey of the literature pertaining to refeeding, parallels the presentation in Chapter 5 of this report.

1971-1229
SMITH, L. W.; GOERING, H. K.; and GORDON, C. H.
Nutritive Evaluations of Untreated and Chemically Treated Dairy
Cattle Wastes
Proc. ISLW p. 314-318
Abst: McQ & B C-302

"The objectives of these studies were (a) to determine the in vivo nutritive value of dairy cattle waste with and without sawdust bedding, (b) to determine the effects of several chemicals on these materials, and (c) to determine the effects of physical preparations and conventional feed additions on acceptability and utilization of wastes."

Procedures in feeding tests on sheep are described and results are tabulated. No detrimental effects appeared. "Achievement of greater treatment effects and higher levels of ad lib consumption of the treated wastes remain for further research effort."

1971-1230
SMITH, L. W.; GOERING, H. K.; and GORDON, C. H.
Nutritive Evaluation of Dairy Cattle Waste
Maryland Nutrition Conf. Proc. 6 p.

Fecal fiber is being enhanced chemically to enhance digestibility. Sodium hydroxide is suitable for the purpose because of low cost and effective degradative action on cell walls. Sodium chlorite is a specific delignifying chemical. Data are tabulated. "The chemical treatment of feces by the addition of 3% NaOH resulted in a two fold increase in DM [dry matter] and cellulose digestibility, a four fold increase in CW [cell wall] digestibility, and a ten fold increase in hemicellulose digestibility." Sheep responded well to pelletized feeds containing as high as 93 percent barn wastes.

1971-1231
SMITH, L. W. and GORDON, C. H.
Dairy Cattle Manure -- Cornmeal Rations for Growing Heifers (Abst)
Jnl. Animal Sci. 33: 300
Abst: McO & B B-240

Iso-nitrogenous rations with one part cornmeal and one, two, or three parts manure consisting of feces and peanut hull bedding were fed to heifers on a 90-day trial. After 60 days alfalfa was added to all diets for two weeks to control bloating. There were no significant differences in growth rates or in feed-to-gain ratios.

1971-1232
SMITH, R. J.; HAZEN, T. E.; and MINER, J. Ronald
Manure Management in a 700-Head Swine-Finishing Building; Two
Approaches Using Renovated Waste Water
Proc. ISLW p. 149-153
Abst: McO & B C-254

A series of tests marred by mechanical failures indicate the feasibility of reusing the supernatant from an anaerobic lagoon, either directly or after further treatment in an oxidation ditch, for flushing a swine building. "The quality of flush water seemed far less important than the quantity." For safe disposal of the overflow, it was used for irrigation of adjacent cropland.

1971-1233
STALEY, L. M.; BULLEY, N. R.; and WINDT, T. A.
Pumping Characteristics, Biological and Chemical Properties of Dairy
Manure Slurries
Proc. ISLW p. 142-145
Abst: McO & B C-252

For a high winter-rainfall area in British Columbia with a high water table it was desired to dispose of manure from a 150-head dairy herd on 120 acres without resorting to wheel transport from November through February. Aboveground slurry storage and pumping through an irrigation pipeline proved to be feasible.

A helical-type positive displacement pump is recommended. The total solids should be kept under eight percent, but unnecessary dilution should be avoided. Employ a pressure relief valve and protect against clogging by excluding straw, long hay, grass, and wood chips.

1971-1234
STEPHENS, E. R.
Identification of Odors from Cattle Feedlots
Western Livestock Jnl. 49: June p. 66-67

The University of California at Riverside studied feedlot odors during 1967, 1968, and 1969. Little research has been done on the problem which involves measurements of a few parts per billion. Low-molecular amines, particularly trimethylamine, are the major source, but there are others.

1971-1235
STEPHENS, Edgar R.
Identification of Odors in Feedlot Operations
EPA Pbln. SW-5r.2 p. 24

Gas chromatography was employed to identify the odors associated with feedlots. Trimethylamine was found to be present in concentrations well above its threshold level as were ethylamine or methylamine, propylamine, and butylamine. Ammonia and hydrogen sulfide, while present, were below their threshold levels.

1971-1236
STEPHENS, G. R.; HILL, D. E.; AHO, W. A.; and HALE, W. S.
Utilizing Liquid Poultry Manure Safely in Pine Plantations (Abst)
Poultry Sci. 50: 1634
Abst: McO & B B-303

After applying 0, 17, and 100 tons of wet poultry manure per acre to 35-year-old white pines and monitoring the surface soil and groundwater, it was concluded that 17 tons (400 lb N) was a safe application but that 100 tons was excessive.

1971-1237
STEWART, T. A. and McILWAIN, R.
Aerobic Storage of Poultry Manure

Proc. ISLW p. 261, 262, 266
Abst: McQ & B C-286

An oxidation ditch installed under a poultry shed in Northern Ireland provided a satisfactory atmosphere in the shed and presented no major problems. The ditch extended outside the shed with a cleanout access and the rotor in the outer portion. Foaming occurred when feathers and floating sludge formed a solid layer. It was necessary to break up and remove the crust several times per year. Rotor bearings require replacement from time to time.

1971-1238
SURBROOK, T. C.; SHEPPARD, C. C.; BOYD, J. S.; ZINDEL, Howard C.; and FLEGAL, Cal J.
Drying Poultry Waste
Proc. ISLW p. 192-194
Abst: McQ & B C-266

Manure dryers have been too expensive and complicated for use on the farm. A dryer developed at Michigan State University is described and its performance is analyzed. It reduces odor and produces a stable dry product, samples of which have been stored two years without deterioration. Protein and nitrogen losses of up to 25 percent occur in the process. Costs, capital and operating, were calculated to be: poultry manure $7.80/ton, cattle manure $11.31/ton, and swine manure $11.96/ton. ". . . manure can be dried successfully on the farm."

1971-1239
SWANSON, Norris P. and GILBERTSON, Conrad B.
Feedlot Waste Management: Some Solutions to the Problem
ASAE Paper 71-522 6 p.
Abst: McQ & B G-105

Measurement of feedlot waste is complicated by variation in moisture content, mixing with soil, inclusion of bedding and spilled feed, and on-site decomposition. "Settling basins or debris traps are used to retain solids transported by runoff on a feedlot."

Runoff measurement, particularly for quality determination, is complicated by viscous flow and negligible settling in cold weather, by the existence of both bedloads and suspended loads, and by interference with sediment content by many standard measuring devices. Parshall flumes and time-sequenced, rotating dipper, proportional samplers are satisfactory.

1971-1240
SWANSON, N. P.; MIELKE, L. N.; LORIMOR, J. C.; McCALLA, T. M.; and ELLIS, J. R.

Transport of Pollutants from Sloping Cattle Feedlots as Affected by
Rainfall Intensity, Duration, and Recurrence
Proc. ISLW p. 51-55
Abst: McQ & B C-226

Artificial rainstorms were produced on an old, established unpaved feedlot in eastern Nebraska with slopes of 12.5-13 percent. Natural rainfall was measured (quantity and intensity) on another feedlot with a six percent slope. Tabulations of runoff, solids loss, conductivity, COD, P, Organic N, NH_4-N and NO_3-N are given. The solids removed by high-intensity simulated rain were predominantly soil. Among the seven conclusions stated was: "Feedlot runoff may contain 75 times the P content, up to 30 times the NH_4-N content, and up to 4 times the NO_3-N content of runoff from fallow land."

1971-1241
TAIGANIDES, E. Paul
Engineering Properties of Farm Wastes
EPA Pbln. SW-5r.2, p. 21-22

The compounds in manure contributing to the odor nuisance were identified, and levels of noxious gas produced in animal confinement units were determined. Parameters governing the maximum quantity of manure which can be spread on land in a given period were determined to be the storage capacity, quantity of waste generated, and land area available. Products of combustion and biological treatment were identified and measured.

1971-1242
TAIGANIDES, E. Paul and STROSHINE, Richard L.
Impact of Farm Animal Production and Processing on the Total Environment
Proc. ISLW p. 95-98
Abst: McQ & B C-238

Manure is the largest single source of solid wastes in the U. S. If spread uniformly on the cropland, each acre would receive three tons of wet manure containing 48 lb of nitrogen, 15 lb of phosphate, and 16 lb of potassium per year. This would satisfy fertilizer needs. "Therefore, the best use of manures is application on land for crop production."

1971-1243
TAIGANIDES, E. Paul and WHITE, Richard K.
Automated Handling, Treatment and Recycling of Waste Water From an
Animal Confinement Production Unit
Proc. ISLW p. 146-148
Abst: McQ & B C-253

In a plant under test at Botkins, Ohio, the manure from a confinement unit for 500 pigs is flushed to the treatment unit where solids are separated from the liquid by screening. The solids are aerobically digested, deodorized, and stored for spreading on cropland. The liquids discharge into an oxidation ditch. Effluents from the ditch are clarified and reused as gutter flush water. Provision to disinfect the recycled water can be incorporated in the system. Design details are described.

1971-1244
TAIGANIDES, E. Paul; WHITE, Richard K.; and STROSHINE, Richard L.
Water and Soil Oxygen Demand of Livestock Wastes
Proc. ISLW p. 176-179
Abst: McQ & B C-261

The BOD test is of questionable value when applied to animal wastes since manure is a solid waste with disposal to land rather than a liquid with disposal to water. It is, however, useful in discussing liquid manure handling systems and sewage-treatment waste adaptations. Testing procedures, appropriate units, and results are discussed. "Oxygen demand per unit of waste appears to be the same in either soil or water."

1971-1245
TAYLOR, Jack C.
Regulatory Aspects of Recycled Livestock and Poultry Wastes
Proc. ISLW p. 291-292
Abst: McQ & B C-295

Manure has been processed for animal feed by drying or ensiling and by digester-type processes using algae, chemicals, or fly larvae. The Food and Drug Administration has no objection to the making of tests, but before approval of the process for commercial production is granted it must be convinced that the product to be fed has nutritional value and that it has no harmful effects, immediate or cumulative, on animals or man. In particular, residues of antibiotics, metal supplements, or other drugs must be proved safe. Reports of feeding experiments in the literature are summarized and fifteen references are appended. "At this time, FDA does not have enough information to modify its present regulation."

1971-1246
TAYLOR, Jack C.
Regulatory Aspects of Recycled Livestock and Poultry Wastes
Proc. Natl. Symp. on Animal Waste Mgmt. p. 129-131
Abst: McQ & B C-344

". . . the FDA has not sanctioned and does not sanction the use of poultry litter as a feedstuff for animals."

"FDA does not have grant-in-aid funds available for research with waste products."

Procedures for requesting FDA approval are outlined. See [1971-1245].

1971-1247
TEN HAVE, P.
Aerobic Biological Breakdown of Farm Waste
Proc. ISLW p. 275-278
Abst: McQ & B C-290

In the Netherlands slurries from poultry, veal, and swine are usually diluted to about two to three percent TS. While oxidation ditches were once popular, "today, surface aerators with a vertical shaft are much cheaper than rotors." They also give less trouble with bearings. BOD of effluent is reduced by 95 to 99.5 percent.

1971-1248
THOMAS, J. W. and ZINDEL, Howard C.
Feeding Dehydrated Poultry Waste to Dairy Cows
Mich. State Univ. Ag. Ex. Sta. Rsch. Bull. 152 p. 8-11
Abst: McQ & B E-206

Dried poultry waste was included as 30 percent of the diet of milk cows without adverse effect on quantity or quality of milk in trials at Michigan State. Data are tabulated in the article.

1971-1249
THYGESON, John R.
Research on an Animal Waste Pollution Control System
EPA Pbln. SW-5r.2, p. 34

The objectives of this study are "to investigate the possibility of rendering animal wastes innocuous by steam drying and to determine the nutritional value of the dried wastes in hopes that they can be used as animal feed." Equipment has been developed and tests on physical properties of manure are being conducted,

1971-1250
THYGESON, John R.; GROSSMANN, E. D.; and MacARTHUR, Joseph
Through-Circulation Drying of Manure in Superheated Steam
Proc. ISLW p. 185-189
Abst: McQ & B C-264

"Drying systems applied to animal wastes in agriculture often have the following disadvantages: high capital investment, high operating cost, major air pollution hazard, doubtful value of dried product and significant operating and maintenance problems. These deficiencies, however, should be weighed against the benefits of a large weight reduction in the waste, and the production of a relatively odorless and stable dry solid. This paper describes a new drying system which minimizes the disadvantages mentioned above. It also provides unique benefits that greatly enhance drying as an economic manure treatment method."

The equipment and process are sketched schematically and described. The manure is preformed into pellets and superheated steam is blown through the interstices at high velocity. The end products are a dry, odorless solid and a clear liquid condensate suitable for irrigation or, after purification, for recycling to boiler feed water.

1971-1251
TIETZ, Neil
FDA Holds Firm on Feeding Litter, But Encourages Further Research
Feedstuffs 43: 24 Apr. p. 1, 40

TIETZ reports on the session on Refeeding at the International Symposium on Livestock Wastes. The following papers are abstracted:

W. B. ANTHONY, "Manure as Feed" [1971-1014],

H. F. BUCHOLTZ, "Dried Poultry Waste as a Protein Supplement for Feedlot Cattle and Sheep" [1971-1040],

Leonard S. BULL, "Nutritive Value of Chicken Manure for Cattle" [1971-1041],

C. C. CALVERT, "Biodegraded Hen Manure and Adult House Flies: Their Nutritional Value to the Growing Chick" [1971-1049],

C. J. FLEGAL, "Dehydrated Poultry Waste in Poultry Rations" [1971-1090],

J. P. FONTENOT, "Broiler Litter for Ruminants" [1971-1095],

Brian HODGETTS, "Dried Poultry Waste in the Feed of Laying Hens" [1971-1133],

L. W. SMITH, "Untreated and Chemically Treated Dairy Cattle Wastes" [1971-1229], and

Jack C. TAYLOR, "Regulatory Aspects of Recycled Livestock and Poultry Wastes" [1971-1245].

1971-1252
TURNBULL, J. E.; HORE, F. R.; and FELDMAN, M.
A Land Recycling Liquid Manure System for a Large-Scale Confinement Operation in a Cold Climate
Proc. ISLW p. 39-43
Abst: McQ & B C-223

Manure recycling of the cattle and sheep portion of the Greenbelt Farm facility of the Canada Department of Agriculture's Animal Research Institute in the suburbs of Ottawa is described. The ground being frozen 2.5 months per year and the water table approaching to within two to three feet of the ground surface, special precautions in provision of storage and design of storage tanks were required. Provision was made for one-to-two months storage of liquid manure within the animal buildings, and for four-to-five month storage in separate concrete tanks nearby. Land disposal with an acceptable maximum of 45 to 50 tons per acre by means of vacuum tank trucks followed by a plow which covers the manure within seconds is described. Possible modifications are under study.

"Recycling the waste for re-use minimizes the change in the balance of nature which in turn minimizes the potential for polluting the environment."

1971-1253
TURNER, D. O. and PROCTOR, D. E.
A Farm Scale Dairy Waste Disposal System
Proc. ISLW p. 85-88
Abst: McQ & B C-235

Experimentation at Monroe, Washington, (50-in. ann. pcpn., 70 percent in winter) indicates that roofed confinement pens, an anaerobic lagoon capable of six-month storage, and distribution to fields by pipeline and "manure gun" with a rate of application of one acre-inch with ten percent suspended solids just after harvest, and up to five acre-inches prior to seeding silage corn is effective. Nitrate concentrations did not become excessive.

1971-1254
USDA ANIMAL SCIENCE RESEARCH DIVISION, ARS
Animal Waste Reuse -- Nutritive Value and Potential Problems from Feed Additives: A Review
USDA ARS 44-224 56 p.

This report contains surveys of the literature on specific problems followed by an extensive list of the literature cited (p. 42-56). The individual papers, abstracted separately, are:

CALVERT, C. C., Fecal Residues from Feed Additives -- Poultry [1971-1048],

DINIUS, D. A., Fecal Residues from Hormones and Antibiotics -- Beef Cattle [1971-1072],

FROBISH, L. T., Fecal Residues from Feed Additives -- Swine [1971-1097],

MILLER, R. W., Fecal Residues from Larvicides -- Poultry and Cattle [1970-1063], and

SMITH, L. W., Feeding Value of Animal Wastes [1971-1228].

1971-1255
VIETS, Frank G., Jr.
Cattle Feedlot Pollution
Agric. Sci. Review V. 9, No. 1 (1971)
Reprint: Natl. Symp. on Animal Waste Mgmt. p. 97-105 (1971)
Abst: McQ & B C-340

"The solution to the problem is to return the solid waste to the land in sufficient amounts for near maximum production of crops without waste of the animal feces resource."

"If runoff cannot be disposed of economically in humid areas, cattle feeding will be forced westward to drier climates. A long-range balance between availability of feed grains and ease of runoff disposal will likely be established."

Air pollution is considered to be the most serious problem associated with feedlots. Zoning may be a partial answer.

1971-1256
WATKINS, Ralph
Pollution Laws Getting Tougher
Beef 7: Jan. p. 26-28

Papers at the annual convention of the National Livestock Feeders Association in Des Moines are summarized. Cost of compliance with antipollution legislation was the topic emphasized.

1971-1257
WELLS, Dan M.
Factors Affecting Quality and Quantity of Feedlot Waste Collections
Soil Conservation Service - Texas Tech Workshop. Lubbock. 28-29 July.
3 p.

The factors affecting runoff from beef cattle feedlots have been found to be size of cattle, density of cattle, slope of feedlot, type of surfacing material, type of ration fed, climatic factors, and frequency of cleaning. Of these, climate, ration and surfacing material have predominant significance.

1971-1258
WELLS, Dan M.; ALBIN, Robert C.; GRUB, Walter; COLEMAN, Eugene A.; and MEENAGHAN, George F.
Characteristics of Wastes from Southwestern Cattle Feedlots
EPA WPC Rsch. Series 13040 DEM xi + 88 p.
Reprint (In part) Proc. Cornell Agr. Waste Mgmt. Conf., p. 385-404 (1972)

Laboratory and field testing of cattle feedlot runoff from concrete-paved and dirt feedlots on different slopes, with and without cover, with different cleaning programs, different stacking densities, and with differences in the cattle feed ration are reported and analyzed. A good survey of the literature (72 references cited) is included. In addition, 13 other papers by the authors are listed.

Major conclusions, of which the applicability may in some cases be restricted to feedlots in a similar climate, are:

1. The variations of conditions mentioned are of no real significance from the standpoint of water quality control.

2. Treatment by conventional anaerobic or aerobic processes of precipitation-induced feedlot runoff is infeasible.

3. Concentration of pollutants from concrete-surfaced lots is two to four times greater than that from dirt lots.

4. Quantity of waste is a direct function of the fraction of roughage in the ration.

5. Treatment by aerobic composting is technically feasible.

6. Extreme caution must be exercised if runoff is used to irrigate crops. With proper timing, limited quantities may be beneficially applied to most well-established crops.

7. Build up of Na^+, Cl^-, and other ions in the soil may result from repeated applications of feedlot runoff.

1971-1259
WESLEY, R. L.; HALE, E. B.; and PORTER, H. C.
The Use of Oxidation Ponds for Poultry Processing Waste Disposal

Proc. ISLW p. 286-287
Abst: McQ & B C-293

To renovate the waste-disposal facilities of a poultry processor in Virginia discharging 100,000 gal/day of effluent, 4000 ft of pipe and 37 acres of land were acquired and two lagoons followed by three small holding vats were installed. Effluent from the third vat flows 250 ft in a boulder-strewn channel for further aeration. BOD reduction of 97 percent is obtained. TS reduction is 32 percent at 10°C, 89 percent at 20°C, and 96 percent at 30°C. Discharge is to a stream.

Plans exist for making additions to the system which will permit recycling on the property with no discharge to state waters.

1971-1260
WHITE, Richard K. and TAIGANIDES, E. Paul
Pyrolysis of Livestock Wastes
Proc. ISLW p. 190-191, 194
Abst: McQ & B C-265

Investigations on the pyrolysis ("anaerobic incineration") of wastes of vegetative origin -- wood, paper, rubber, etc. -- indicate that the process may have promise in waste disposal. Laboratory tests conducted by the authors on animal wastes are described and the results are tabulated. The BTU equivalent per lb of total solids was found to be: beef cattle 1900, poultry 1640, swine 1400. Further research is needed.

1971-1261
WHITE-STEVENS, Robert
Methods of Recycling Animal Wastes
Poultry Digest 30: 43

Methods listed are:

1. Composting and seasonal spreading on land.
2. Slurrying, lagooning, and irrigation spraying.
3. Drying, grinding, selling for soil amendment.
4. Drying, grinding, feeding as ration supplement.
5. Drying, fermenting, producing single cell protein for livestock feed.
6a. Slurrying, lagooning, raising algae, feeding algae to stock.
6b. Feeding algae to zooplankton, zooplankton to shrimp, shrimp to dace or carp, dace to bass or trout.
7. Anaerobic digestion for methane gas.
8. Hydrogenation in a closed oxygen-free vessel for methane gas.

1971-1262
WILKINSON, S. R.; STUEDEMANN, J. A.; WILLIAMS, D. J.; JONES, J. B., Jr.; DAWSON, R. N.; and JACKSON, W. A.
Recycling Broiler House Litter on Tall Fescue Pastures at Disposal Rates and Evidence of Beef Cow Health Problems
Proc. ISLW p. 321-324, 328
Abst: McQ & B C-304

Fertilization of tall fescue pastures in northern Georgia has appeared to be profitable as it provided extensive grazing and limited erosion on slopes. After beef cattle began suffering from grass tetany and/or nitrate toxicity a series of experiments was undertaken. As a result it is recommended that poultry litter disposal be limited to nine MT per ha per year on tall fescue.

1971-1263
WILLRETT, James
Best Future for Manure Is As Liquid
CALF News 9: Feb. p. 52

WILLRETT, a cattle feeder at Malta, Illinois, reports success with totally-enclosed slat-floored barns in which manure accumulates in the basement at a rate of about one foot per month. High-capacity pumps fill a 2000-gal tank in 60 to 75 seconds. The contents are spread in a 20-ft swath before the ground freezes and again in the spring.

1971-1264
WILLRICH, T. L. and MINER, J. Ronald
Litigation Experience of Five Livestock and Poultry Producers
Proc. ISLW p. 99-101
Abst: McQ & B C-239

Nuisance and trespass litigation can often be sustained under common law. Violation of zoning and anti-pollution regulations may be actionable. Five recent midwestern cases are reviewed.

1971-1265
WILLSON, George B.
Composting Dairy Cow Wastes
Proc. ISLW p. 163-165
Abst: Compost Sci. 13: July-Aug. p. 2-3 (1972); McQ & B C-257

WILLSON reports a series of tests on aerobic composting to stabilize dairy cow manure and deduces a set of rules for optimizing the process. Aerobic composting does not produce offensive odors. It is faster and produces more heat than anaerobic composting.

1971-1266
WILMORE, Rex
An Oxidation Wheel That Works
Farm Jnl. 95: Sept. p. 14-15
Abst: Compost Sci 13: Jan-Feb. p. 28 (1972)

A Kansas hog raiser reports five years of operation of an oxidation ditch for a 10,000 hog per year layout with no manure handling and no odor complaints. Costs of the "virtually" maintenance-free setup are reported to be 89 ¢ per hog. Wheel design and mounting with adequate freeboard for the bearings account for the success.

1971-1267
WINDT, T. A.; BULLEY, N. R.; and STALEY, L. M.
Design, Installation, and Biological Assessment of a Pasveer Oxidation Ditch on a Large British Columbia Swine Farm
Proc. ISLW p. 213-216
Abst: McQ & B C-273

A commercial prototype ditch subject to less-skilled maintenance and greater departures from design criteria than the laboratory ditches usually described, functions well. It has given complete odor control and the effluent from the ditch is easily handled by most pumps. Operating costs are about 25 cents per finished hog. Further research is needed to avoid cyclic overloading and excess dilution from drinking water spillage.

1971-1268
WITZEL, Stanley A.
A Study of Farm Wastes
EPA Pbln. SW-5r.2, p. 18-19

The quality, physical character, chemical and biological properties of farm animal wastes, their economic value, and their possible adverse effect on public health were studied. Lagoons may provide partial waste reduction. The ultimate place of safe disposal for farm animal waste is considered to be the soil.

1971-1269
YECK, Robert G.
Generating Public Interest in Waste Management Programs
Agr. Engrg. 52: 623
Abst: McQ & B B-649

"The chances of success for any waste management program will be better when public support is attained." Suggestions for enlisting this support are given.

1971-1270
YECK, Robert G.
Proceedings Prologue to the 1971 International Symposium on Livestock Wastes
Proc. ISLW p. 4-5

This Symposium, sponsored by the American Society of Agricultural Engineers and held on the campus of the Ohio State University, April 19-22, 1971, attracted an attendance of about 600. Abstracts of most of the 102 papers presented appear in this compendium.

YECK surveyed the background for the Symposium and summarized the subject coverage. He observed that the destination of wastes was ultimate incorporation into cropland after processing.

A detailed table of contents appears on p. 2-3 of the Proceedings which appeared as ASAE Publication Proc-271 under the title "Livestock Waste Management and Pollution Abatement."

1971-1271
YECK, Robert G.
Agriculture's Role in Environmental Quality
Pur-o-sphere Convention, Kiamesha Lake, New York 10 p.

"The soil, if properly used, has tremendous capacities for degrading wastes and being regenerated through a cropping system." When, however, as in portions of New York state, land spreading conflicts with a predominant resort industry or a pressing suburbia other means of waste disposal must be found. "Processing of animal wastes by heat treating or ensiling and then refeeding to the animals show promise. Biological separation of protein from the wastes with insects and reclaiming nutrients through harvest of algae are examples of these alternatives."

1971-1272
YECK, Robert G. and SCHLEUSENER, Paul E.
Recycling of Animal Wastes
Proc. Natl. Symp. on Animal Waste Mgmt. p. 121-127
Abst: McQ & B C-343

Land recycling is current best practice. It is, however, expensive and is difficult to use where operations are large, land is scarce, or neighbors are fastidious. Sixteen refeeding processes, described briefly are:

Drying
Cooking
Fumigation
Chemical
Washing
Pyrolysis
Ensiling - Fermentation
Composting
Lagooning
Hydroponics
Insect
Earthworm
Fish
Algae
Yeast
Single Cell Protein

Ultimately, one or more of these may become more common than land spreading.

1971-1273
ZINDEL, Howard C.
Recycled Poultry Nutrients
Poultry Digest 30: 231-233

After a subhead, "Dehydrated poultry manure has proved its value as a feedstuff in the laying ration, and tests show it can be recycled many times," the author tabulates results of feeding various fractions of the ration in DPW to chickens, sheep and cattle. Goats refuse it. "We are hopeful that a realistic recommendation will be forthcoming soon from the Food and Drug Administration."

1971-1274
ZINDEL, Howard C.
Early Experiments at Michigan State University Involving the Use of Chicken Manure
Mich. State Univ. Ag. Ex. Sta. Rsch. Rpt. 152. p. 2-3
Abst: McQ & B E-204

The first work on refeeding of poultry manure at Michigan State was performed in 1954. Concern with antibiotics was of primary interest in this and the somewhat later work by David LIBBY, P. J. SHAIBLE, W. K. WARDEN, and J. D. YATES. The efficacity of autoclaving and/or oven drying in preparing chicken litter for refeeding was cited in several of the early papers.

1971-1275
ZINDEL, Howard C. and FLEGAL, Cal J.
Economics of Dried Poultry Waste (DPW) as a Feed Ingredient or a Fertilizer
Mich. State Univ. Ag. Ex. Sta. Rsch. Rpt. 152. p. 4-7
Abst: McQ & B E-205

Based on assumptions stated in this paper, "the introduction of 25% DPW into the feed replacing the corn results in a saving of $10/ton or 2.0 ¢ per dozen eggs." Wet manure is stated to have a fertilizer value of $2.39 per ton and a cost of spreading of $11.96 per ton. Dried manure, on the other hand. has a value of $50 per ton as an organic fertilizer with a cost of drying and bagging of $26.74 per ton.

1971-1276
ZUROWSKI, Tom
President's Advisory Board Issues 10 Feedlot Pollution Observations
Feedlot Mgmt. 13: Dec. p. 42, 43, 46, 47
Abst: McQ & B F-061

Among observations of the Water Pollution Control Advisory Board which have gone to EPA for review are:

1. Only eight states now have specific feedlot statutes.

2. Animal concentration, with attendant problems of waste control and water pollution, is increasing.

3. In the 17 contiguous western states, cattle create more pollution problems than sheep, swine, or poultry.

4. Potential pollution varies widely with precipitation, land slope, climate, and soil structure.

5. Pollution originating in animal feedlots may affect air and water quality detrimentally in many ways.

6. Many feedlots do not meet present standards.

7. In low-rainfall areas relatively simple drainage and storage provisions will prove to be adequate.

8. Opportunities may exist to use animal wastes for gas, oil, or animal feeds.

9. The objectives of the USDA Rural Environmental Assistance program are sound.

10. Regulations should be as consistent, constant and durable as possible.

1971-1277
SYMPOSIUM
Committee on Feedlot Waste
Soil Conservation Service - Texas Tech Workshop. Lubbock. 28-29 July

Eight papers, abstracted individually, discussed the law and procedures of the State of Texas for the protection of its waters, the factors affecting feedlot waste, the quantity and quality of such waste, the methods of disposing of it, and the design of feedlot pollution abatement systems.

1971-1278
ANON
Livestock Waste: Why Waste It?
Agric. Situation Oct. 4 p.

Methods of utilization or disposal of manure currently used or under investigation are described briefly. These include land disposal, lagoons, the Pasveer oxidation ditch, composting, dehydration, and animal feeding.

1971-1279
ANON
Why Waste Animal Wastes?
Amer. Beef Producer, Nov. p. 10-11

Uses cited include "Ecolite," a building material "five times as light as concrete blocks," fireproof, easily handled, and economical. Made from feedlot manure and discarded glass, it can be used as an air or water filter. A pilot manufacturing plant is to be established at Lovington, New Mexico. The refeeding of cow manure, processed in an oxidation ditch, to steers has been successful in Iowa.

1971-1280
ANON [Based on Walter WOODS]
Feedlots Can Be Too Clean, Nebraska Research Indicates
Beef 7: Feb. p. 39

Studies at Central City, Nebraska, indicate that a thick manure pack on a feedlot tends to absorb high-nitrogen wastes. Microorganisms present convert the nitrogen to gases dispersed into the atmosphere, thus protecting groundwater. The manure pack can be managed to secure considerable decomposition and to restrict runoff from moderate precipitation.

1971-1281
ANON
Waste Research Centers On Using Manure as Feed or Fertilizer
Beef 7: June p. 8, 10

This summary report on the International Symposium on Livestock Wastes cited a number of papers of especial interest to beef producers and observed that the emphasis of the symposium was on management to eliminate problems rather than elaborate machinery to handle them. Reuse, rather than mere disposal, was stressed. There is no single best answer. Variations in climate and other conditions call for different solutions.

1971-1282
ANON [Based on Donald W. THAYER]
Feed 'em Trash, Cut Pollution
Beef 7: July p. 12

"Microbiological research at Texas Tech has shown that feedlot wastes can be used both as a cellulose and a nitrogen source for conversion of it and other waste into a complete cattle feed with a single cell protein base." At the present time yeast is the only microorganism grown for food on a commercial scale, but others could be.

1971-1283
ANON [Based on A. E. OLSON]
Engineer Says Feeders Can Handle Most Pollution Control Practices
Beef 7: July p. 15

The basic requirement is to prevent runoff from the feeder's land. Divert inflow around the lot. Provide a debris basin or broad terrace and drain it to a holding pond. Use the holding pond for irrigation. For new feedlots: avoid streams, put the lot at the top of the slope, and promote county zoning to keep suburbanites from encroaching.

1971-1284
ANON [Based on H. L. SELF]
At Iowa Field Day -- Feeders Hear Woes of Confinement Start
Beef 7: July p. 16-17

At Iowa State University's Allee Experimental Farm an oxidation ditch started up in winter produced vast quantities of ammonia foam. Later this was replaced by protein foam which froze. Plumbing and motor troubles added complications.

1971-1285
ANON [Based on Robert C. ALBIN]
Texas Researcher is Attacking Waste Accumulation at Source
Beef 8: Sept. p. 46

Experiments by Dr. Robert C. ALBIN of Texas Tech have established that the percentage of roughage in a cattle ration can often be cut significantly with no ill effects and with a marked reduction in manure output. Other findings reported are that crowding to less than 40 sq ft per head results in lowered daily gains, less feed consumption and reduced efficiency of feed utilization. Slope of lot surface and amount of shade had no significant effect.

1971-1286
ANON [Based on Gerald FRANKL]
Oxidation Ditch is Cattle Feed Source
Beef 8: Oct. p. 24 Disc. Nov. p. 23

FRANKL is studying means of harvesting bacteria in an oxidation ditch treating cattle manure to obtain a "biologically processed" protein supplement for cattle feed. The ditch effluent tested 46.8 percent protein (dry basis). It does not respond well to drying or other processing and should be fed at point of origin. Cattle tested have done well on the supplement. Cost figures have not been refined yet.

Ferdinand KVIDERA cautions on the public relations aspects "when some Ralph Nader type of crusader finds out that cattle are being fed manure."

1971-1287
ANON [Based on Donald REDDELL]
Challenging Nature's Capacity for Manure Processing
CALF News 9: Feb. p. 58

Manure was spread at rates of 900, 600, 300, and zero tons/acre and plowed in by use of various machines in tests at Pecos and El Paso, Texas. Salt-tolerant high-nitrate-using crops were grown on the plots which were irrigated to hasten decomposition of the manure. "Objectives are (1) to provide a manure disposal bed that would alleviate odor and insect problems, (2) to study the possible pollution effects on the soil and water, and (3) to evaluate different tillage techniques used in the land-fill operation."

1971-1288
ANON
Bacteria Convert Wastes Into $24-a-ton Feed
CALF News 9: July p. 10, 50

Carefully selected bacteria can convert feedlot and other wastes into a complete cattle feed with a single-cell protein base. "What cannot be converted is used by livestock as necessary roughage." The mass of cells can double in 20-60 minutes. The process, being developed at

Texas Tech, requires large quantities of water. The water may, however, be recycled.

1971-1289
ANON
Feedback! Iowa Beef Processors First Recycling Trial Shows Promise
CALF News 9: July p. 22, 24

Gerald FRANKL, Vice President of Iowa Beef Processors and Dr. Richard VETTER of Iowa State University are conducting what appears to be a highly-successful refeeding project using 35 percent processed animal by-product (PAB) at Denison, Iowa. At the end of the first 75 days of test the PAB-fed steers had an average daily gain of 4.19 lb, while the control steers had 4.02 lb. The cattle "love it and are thriving on it."

1971-1290
ANON [Based on Lynn SHUYLER]
EPA's New Feedlot Disposal Plan
CALF News 9: Aug. p. 49, 62

The Robert S. Kerr Water Research Center in Ada, Oklahoma, is attempting to perfect a process wherein a colony of micro-organisms will purify the effluent from a 12,000-head feedlot on 8 to 10 acres of grassy slope. Using a 2-to-6 percent slope, with terraces, on soil too heavy to irrigate, the process removes better than 80 percent of the phosphate and about 95 percent of the nitrogen. A two-pond system is used with effluent being pumped from the second pond after two or three days retention. Start-up requires about six weeks to allow the colony to establish itself. The water supply must be nearly continuous.

1971-1291
ANON
Final Results of PAB-fed Steers
CALF News 9: Sept. p. 8

The steers reported on in [1971-1289] were slaughtered after 133 days feeding. They would have been ready at 110, but the extra time was used in inch the ration up to 65 percent PAB seeking the point at which they would back off the feed; they never did. The carcasses were graded choice.

FRANKL recommends confined feeding, but suggests a concrete slab which can be flushed to gutters leading to an oxidation ditch as an alternative means of salvaging manure for PAB production.

1971-1292
ANON
Feedlot Manure the Ecology Inspired Building Material
CALF News 9: Sept. p. 12

Based on a secret process perfected by Prof. J. D. MACKENZIE of UCLA, Richard and Charles KERSHAW plan to erect a plant in Lovington, New Mexico, to convert treated cow dung (TCD) plus glass in a high-temperature kiln into ecolite, a building product whose specific properties can be varied by varying the TCD/glass ratio of the input.

1971-1293
ANON [Based on Jack TAYLOR and C. C. VAN HOUWELING]
Regulatory Aspects of Recycled Livestock Wastes
CALF News 9: Oct. p. 44

Information which the Food and Drug Administration would require if requested to approve various waste products as sources of animal feedstuffs include 1) the source of the raw materials, 2) a stepwise description of the processing, and 3) a description of the end product and its intended use. Residues from drugs, pesticides, etc.. are particularly suspect.

1971-1294
ANON [Based on Robert C. ALBIN]
Control Manure by Feeding
CALF News 9: Oct. p. 56

Robert C. ALBIN, Texas Tech, found in a series of studies that the amount of manure produced by cattle increased markedly with the percentage of roughage fed. Crowding to below 40 sq ft per head led to lower daily weight gains, lower feed consumption, and lower efficiency of feed utilization. Slope of feedlot surface and amount of shade had no significant effects.

1971-1295
ANON
Process Converts Animal Wastes to Oil
Chem. and Engrg. News 49: 16 Aug. p. 43
Abst: McQ & B F-091

The U. S. Bureau of Mines Division of Coal has been studying the conversion of cellulosic wastes to oil. Manure responds to the process better than most wastes. The process consists of placing the waste in a reaction vessel with carbon monoxide at an initial pressure of 1200 psi, heating to 380°C, and then holding for 20 minutes. A ton of manure will produce three barrels of low-sulfur oil. The oil is difficult to refine to gasoline, but makes an excellent fuel oil. The process is considered to be economically viable.

1971-1296
ANON [Based on Thomas DANKO]
Biological Fly Control Observed in New Hampshire
Egg Industry 4: Jan. p. 20

At a farm in New Hampshire which had a serious fly problem in the poultry house deep pit during its first year of operation, no problem has existed since, thanks to the appetites of some small beetles. No chemicals have been used.

1971-1297
ANON
A Pollution Solution with Built-in Profits
Egg Industry 4: June p. 27-44, 48

The solution of the title is high-temperature drying to convert poultry manure into a pathogen-free product suitable as an organic fertilizer or feed ingredient. "Proponents of the heat-drying techniques are loudly proclaiming that liquid manure handling systems and even the latest rage -- deep pits -- are as outdated as scrubbing boards for doing home laundry. This school of thought -- which is drawing converts as fast as an old-fashioned revival meeting -- says *drying is the only way.* And the drying must be done quickly with extremely high temperatures that pasteurize the product, reduce volume of original manure down to one-third and -- with an afterburner -- eliminate all odor and emissions." The article is developed under the subheadings: "For ecology's sake, dry the wastes;" "Seeking an organic fertilizer market;" "Toasted protein: future of DPW is in use as feed ingredient;" "Handle manure the dry way -- it might save you money;" and "Interest in drying methods is booming."

1971-1298
ANON
Pyrolysis of Refuse Gains Ground
Environ. Sci. and Tech. 5: 310-312

Pyrolysis of wastes as practiced by the U. S. Bureau of Mines, with major emphasis on energy recovery, and of Enviro-Chem, with major emphasis on solid waste disposal, is diagramed and discussed. Enviro-Chem will probably sign a contract with New York City "in the near future for a 1000-ton/day plant to be built on Staten Island."

1971-1299
ANON [Based on George PRATT and R. L. WITZ]
Some Problems to Hurdle
Feedlot Mgmt. 13: Feb. p. 32

Under North Dakota conditions deep snow cover often prohibits manure spreading. Oxidation ditches will reduce solid volume forty percent. Storage, however, is preferably outside the barn to eliminate potentially harmful gases and humidity build-up under temperature conditions not permitting forced ventilation. Dehydration of manure may be justified. "And there's a possibility of using dried manure as fuel."

1971-1300
ANON
Innovative Operation 'Processes' Wastes
Feedlot Mgmt. 13: Mar. p. 22-23
Abst: McQ & B F-053

Six photos, a diagram of the operation, and a financial breakdown of the $50,000 investment ($98.42 per head) on an oxidation ditch at Denison, Iowa, illustrate a means of eliminating manure spreading, handling, and storage. Overflow goes to a lagoon outside the cold confinement barn.

1971-1301
ANON
Processing of Wastes for Feed Shows Promise
Feedlot Mgmt. 13: Apr. p. 48, 50

Scientists at Beltsville, Maryland, having observed that only forty to sixty percent of the energy in forage is utilized by a cow, fed sheep pelleted non-treated cattle wastes as seventy percent of their ration. In other tests dried treated wastes were fed as 85 percent of the ration. "Ill health was not observed in untreated or chemically treated waste fed animals, but this aspect was not specifically investigated."

1971-1302
EDITORIAL [Based on Robert C. ALBIN]
The New Science of Waste Management
Feedlot Mgmt. 13: May p. 9, 46

Technical definitions of major terms used in the literature on manure disposal and utilization are given.

1971-1303
ANON [Based on Gary JOST]
Solution to a Runoff Problem
Feedlot Mgmt. 13: May p. 12-15
Abst: McQ & B F-055

Prompt drainage of a 12,000-head feedlot near Larned, Kansas, to lagoons from which the water can be pumped for irrigation on operator-owned land has solved pollution problems while avoiding accumulation of mud and water in pens with their resulting animal stress and the risks involved in permitting cattle to drink from mudholes. A center-pivot sprinkler system disposes of the water. The lines are flushed with well water after each use for lagoon effluent to avoid corrosion.

1971-1304
ANON
Spreading Systems Bury Odor of Liquid Manure
Feedlot Mgmt. 13: May p. 20
Abst: McQ & B F-056

The Canadian Department of Agriculture has developed systems for delivering liquid manure to the land and injecting it directly or plowing it under within seconds after spreading. Odors are prevented and fertilizer values otherwise destroyed by sun and air are preserved. Much attention is still required to reduce the costs involved.

1971-1305
ANON [Based on Richard K. WHITE]
Wastes May Provide Fuel for Heating
Feedlot Mgmt. 13: June p. 31

Fifty to sixty percent of the gases produced by "anaerobic incineration" have fuel value. The heat content of manure is stated to be: poultry 7200 Btu/lb, beef cattle 6400, swine 5500, and dairy cattle 5000. Volume reduction and the production of dry innocuous residue are other advantages of pyrolysis.

1971-1306
ANON [Based on Keith S. MAYBERRY]
Plant Nutrient Score on Feedlot Manure
Feedlot Mgmt. 13: June p. 40, 44

It is suggested that feedlot operators obtain data on the value of the N, P, K, and micronutrients of their manure to increase its acceptability by local crop farmers. Not all chemical value is instantly available, and combinations of manure and commercial fertilizers may be most effective. Manure improves soil structure and enhances microbial activity. Salt accumulations may be detrimental in some localities. Use on sandy soils for the growing of salt-tolerant crops may be worth investigating.

1971-1307
ANON
Liquid Waste Seeps From One Basin to Another
Feedlot Mgmt. 13: June p. 56-57
Abst: McQ & B F-058

A 1000-head feedlot at Nebraska City, Nebraska, uses a debris basin separated by a rockfilled wall from a "blackwater basin." From here water is pumped to a grass-covered hillside draining to a terrace. Water from the terrace is pumped to cropland. Costs were $27 per animal.

1971-1308
ANON
Waste Systems, Regulations Rate High Priority in Feedlot Design
Feedlot Mgmt. 13: Oct. p. 52, 58-59

This summary of a three-state conference (New Mexico, Oklahoma, Texas) at Amarillo to develop a manual on feedlot pollution control quotes J. C. WITHEROW, M. R. SCALF, and L. R. SHUYLER of Ada Oklahoma, on the gravity of the pollution problem, the need for well-considered design of facilities to handle the disposal ("A 20,000-head capacity feedlot will require 1,667 acres to dispose of the solid manure produced annually"), and the relative merits of liquid vs. solid manure handling. State regulations in the three states were described.

1971-1309
ANON [Based on Russell ADAMS]
Plowing of Feedlot Manure Advised
Feedlot Mgmt. 13: Dec. p. 20

Greenhouse tests in Minnesota with turkey manure applied at 20 tons/acre-month indicated that plowing added less nitrate than discing or slurry application -- and thus, involved less risk of groundwater pollution.

1971-1310
ANON
Method Shown for Recycling Waste; FDA Attitude Held Important
Feedstuffs 43: 3 Apr. p. 4, 51

In a meeting at Winchester, Kentucky, a drying system capable of converting forty tons per day of poultry manure to "fertilizer and other useful organic products" was demonstrated. Several papers were presented. Howard C. ZINDEL, reporting on multi-cycle refeeding tests at Michigan State, observed that "present research has revealed that dried poultry waste should not be considered as a feed additive, but rather as a feed ingredient. I am of the opinion that the jurisdiction for this new feed ingredient should probably come under the regulation of the states with broad guidelines from FDA." John TUTTLE, Gary BILLIARD, Harvey HAMILTON, I. J. ROSS, and David GRAHAM also spoke on various aspects of recycling.

1971-1311
ANON
Recycling Waste: The Potential and the Problems
Feedstuffs 43: 7 Aug. p. 2, 55
Abst: McQ & B F-105

A number of opinions are quoted on the present justification of the FDA ban on recycling of poultry wastes. The work of James CARSON of Purdue on using dried poultry waste as turkey litter and of Howard C. ZINDEL of Michigan State on recycling of poultry wastes is described.

1971-1312
ANON
Animal Waste Disposal
Feedstuffs 43: 14 Aug. p. 30

National Hog Center discharges effluent "cleaner than most industrial or municipal wastes" into the Fraser River in British Columbia. Treatment is by an anaerobic lagoon with a 30-day detention time and a Pasveer ditch.

1971-1313
ANON
Cornmeal-Manure Ration
Feedstuffs 43: 14 Aug. p. 51

Lewis W. SMITH and Chester H. GORDON of the USDA, Beltsville, Maryland, have reported on tests of feeding heifers on cornmeal and manure in ratios 1:1, 1:2, and 1:3 *ad libitum* for 90 days. Average daily gains for the three rations were 0.47, 0.41, and 0.40 lb respectively. Bloating was relieved by feeding 115 gm of long alfalfa per day. The high cost of drying manure and its low digestibility make these rations uneconomical at present.

1971-1314
ANON
Recycling Waste: Research Shows What Can Be Done
Feedstuffs 43: 14 Aug. p. 64-66

Papers presented at the International Symposium on Livestock Wastes and elsewhere on refeeding of dried manure are summarized. Other means of recycling being investigated are: composting and seasonal spreading; slurrying, lagooning and irrigation spraying; drying, comminuting, and fermenting to produce single-cell protein to be fed; slurrying, lagooning, aerating, fermenting, and production of algae as feed; anaerobic digestion to produce methane gas; and hydrogenation to produce methane gas.

1971-1315
ANON [Based on Robert C. ALBIN]
Texas Tech Scientist Cites Rations' Effect on Waste Accumulation
Feedstuffs 43: 25 Sept. p. 4

Tests on feedlot steers resulted in daily manure production of 2.2 lb with zero roughage, 4.5 lb with 10 percent roughage and 5 lb with 12 percent roughage. While zero percent is not presently practical, significant reductions in manure volume can be obtained by reducing roughage in many cases. Slope and shade had little effect, but reduction of space below 40 sq ft per steer reduced performance.

1971-1316
ANON [Credited to Pfizer Feeder Facts]
New Waste Recycling System Said Nearing Demonstration Stage
Feedstuffs 43: 20 Oct. p. 4

An unnamed concern from outside the field of agri-business is reported to be about to erect a pilot plant in the Southwest in which thermophilic micro-organisms will convert cellulose and lignin to microbial protein which may be used for animal feed. Basic research has been completed.

1971-1317
ANON
Feeding Wastes
Feedstuffs 43: 11 Dec. p. 14

Tests at Michigan State University in the feeding of dried swine feces (DSF) and dehydrated poultry waste (DPW) to swine are described. It was concluded that finishing pigs will consume corn-soy rations containing up to 22 percent of DSF at 90 to 95 percent full appetite, that rate and efficiency of gain will be depressed by the incorporation of DSF in corn-soy rations to replace all or most of the soybean meal, that inclusion of DSF does not affect flavor or acceptability of the meat, and that DPW is of somewhat less value than DSF in swine rations.

1971-1318
ANON [Based on Walter LANGSTON. Credited to Ohio Farmer]
Fermented Poultry Manure Recycled
Poultry Digest 30: 190

LANGSTON, of Midwest Research Institute, "has worked with a 250,000-layer operation in which manure is collected in a tank where it is made into a slurry so it can be pumped. It is heat treated to kill disease organisms. Then, bacterial fermentation is used to upgrade the material so that it can be fed to the animal or bird, either as a wet material or dried. The entire process takes less than 36 hours."

No ill effects appeared with recycling through the same chickens several times.

1971-1319
ANON [Credited to Poultry World 15 Apr.]
Poultry Manure Dried with Microwaves
Poultry Digest 30: 391

A British firm is reported to have developed a microwave drier with a one-ton per hour output. Costs of $2.40 per ton for continuous operation or $5 per ton on a forty-hour week are quoted for the machine which is priced between $50,000 and $60,000. "Dried manure emerges in a wide continuous strip. Since there is no odor, it would make a suitable garden fertilizer, but it is believed that the main outlet will be for ruminant feeds."

1971-1320
ANON [Based on G. Alex MILLS]
Manure -- New Source of Crude Oil?
Poultry Digest 30: 493

The U. S. Bureau of Mines has produced low-sulfur crude oil from manure with a ton of oil and a ton of water being obtained from two tons of manure. No problems are anticipated in scaling up to a full commercial operation, but a minimum of two more years of work will be necessary.

1971-1321
ANON [Based on W. R. FOX. Credited to Miss. Farm Rsch. Aug. '71]

Oxidation Pond Effluent Suitable for Irrigation
Poultry Digest 30: 506

Application of 23.8 inches of irrigation water in 17.5 months from an oxidation pond in Mississippi did no harm. The nutrients were insufficient to maintain a high level of crop production. Rainfall during the period was 81.95 inches.

1971-1322
ANON [Based on George R. STEPHENS and David E. HILL. Credited to Conn. Poultry Notes, Sept. '71]
Forest Land for Manure Disposal
Poultry Digest 30: 553

"Liquid manure was applied with a tractor-drawn tank spreader across a 30-ft swath in a white pine plantation." It dried quickly and was dispersed by rains within two months. Flies were not attracted and the trees used the nitrogen effectively. Application rates must be governed to avoid nitrogen build-up in groundwater.

1971-1323
ANON
Drying Manure Reduces "Biddy Odor" at Berry Best Egg Farm
Poultry Tribune 77: Jan. p. 60, 62

An oil-fired drier capable of converting 10,500 lb of wet manure (75 percent moisture) into 3200 lb of dried product (10 percent moisture) in an 8-hour run at a cost of $20/ton (dry basis) is described. "The dry product makes an excellent organic fertilizer or it can be used as recycled nutrients since it is high in protein, amino acids, phosphoric acid, and potash."

1971-1324
ANON
Use Manure -- Solve Disposal Problems
Successful Farmer 69: Oct. p. 44

Manure is valuable as a fertilizer (about $4 per ton) and as a soil conditioner. It may be particularly useful on grass since grass has a high nitrogen requirement.

1971-1325
ANON
Ways to Handle Swine Wastes
Wallaces Farmer 96: 13 Feb. p. 46

A recently issued bulletin of the National Pork Producers Council described methods of handling swine wastes. An oxidation ditch under a slotted floor will minimize odors, reduce organic wastes up to 50 percent, and produce an effluent suitable for application to cropland at an operating cost of 0.6 to 1 ¢ per hog per day. An aerated lagoon is similar to an oxidation ditch, but is outside the building. It is ineffective in freezing weather. An anaerobic lagoon, the most common facility at present, produces odors when overloaded, especially in late spring and early summer; it is inactive in cold weather.

1971-1326
ANON [Based on O. I. BERGE et al]
Costs of Manure Systems and Operations Compared
Wallaces Farmer 96: 13 Mar. p. 72

Costs for a 50-cow dairy, which produces 685 tons of manure per year, are quoted as follows: for daily field spreading $3200 capital and $2000 annual operating; for stacking $4400 capital and $1500 annual operating; for liquid storage (assuming 150-day accumulation and contract labor) $14,000 to $16,000 capital and $2500 annual operating.

1971-1327
ANON
Electrolytic Treatment of Farm Waste
Water and Waste Trtmt. 14: Oct. p. 9-10

An automatic ten-step slurry purification unit developed by Halmarl and obtainable on the British market is described. A unit capable of handling the manure from 100 dairy cows or 300 pigs will fit in an octagonal timber building 16 ft in diameter and 10 ft tall. The unit handles slug flows without difficulty, is not subject to blockage with inert material, can be erected in two days with simple tools, has low power consumption, and has low operating and maintenance costs.

The effluent may be reused for flushing or may be discharged to streams.

1971-1328
ANON
Farm Wastes: A Symposium
Water Poll. Control 70: 108-110

The program and abstracts of 18 papers in a symposium held at the University of Newcastle upon Tyne 7-8 Jan., 1970, are given.

1971-1329
ANON [Based on Kenneth E. McCLURE]
Feeding Tests Confirm Digestibility of Manure
Western Livestock Jnl. 49: Nov. p. 70

Sheep did well on a ration of 45 percent dried cattle manure, 5 percent molasses, 20 percent alfalfa meal, 1 percent trace-mineralized salt, and 29 percent ground shelled corn. Where the cattle had been corn fed, their feces still contained 36 to 40 percent digestible dry matter.

1971-1330
ANON
Reports and Recommendations of Working Groups
Proc. Natl Symp. on Animal Waste Mgmt. p. 179-185

Information programs should be coordinated and rendered more effective. Education and training programs should be initiated and expanded. Technical assistance should be broadened, accelerated, and more adequately funded. Financial assistance should be increased significantly. Research and development should be intensified in odor control, land application, and recycling. Legislation and regulation should be improved.

1972-1001
ADAMS, John B.
Dairy Farmer Concerns of Laws and Regulations Affecting Animal Waste Management
Proc. Cornell Agr. Waste Mgmt. Conf. p. 97-100

Dairy farmers may be caught between public health laws requiring removal of manure to assure milk sanitation and water pollution control laws forbidding spreading of manure on snow or frozen ground. Unemotional practical solutions are required.

1972-1002
AGENA, Ubbo
Application of Iowa's Water Pollution Control Law to Livestock Operations
Proc. Cornell Agr. Waste Mgmt. Conf. p. 47-59

The Iowa Water Pollution Control Commission has authority over agricultural, as well as other, pollution. The paper reviews its history. The Commission cooperates with other state and federal agencies in accomplishing its purpose.

1972-1003
ANDERSON, Donald F.
Implications of the Permit Program in the Poultry and Animal Feeding Industry
Proc. Cornell Agric. Waste Mgmt. Conf. p. 25-45

By executive order the Corps of Engineers, U. S. Army, was directed to regulate discharge of effluents from poultry and animal feeding operations to navigable waters and their tributaries effective 30 July 71. By a court order issued 23 Dec 71 ". . . there can now be no permits issued at all, and therefore no discharge tolerated."

A zero-discharge philosophy is needed. Methods of accomplishing this include closed-confinement operations with an oxidation ditch and some means of polishing the effluent which will have received 95 percent treatment in the ditch. An oxidation ditch has low capital, operating, and management requirements. Land disposal requires the determination of limits of assimilative capacity. Bio-filters handling spray irrigation hold promise. Refeeding and pyrolysis merit intense study.

1972-1004
ANDERSON, Earl D.
Managing Animal Waste Disposal Systems
Farm Qtrly. 27 (2): 56-58
Abst: McQ & B F-031

The poor reputation lagoons have acquired in some areas is often the result of poor design, poor location, or improper management. They can be effective in Missouri, less so to the north, and more so to the south.

Management suggestions include keeping the water level nearly constant, starting the lagoon at the beginning of warm weather, keeping the pH above 6.7 by adding lime or lye, loading continuously or at least daily, allowing two years for the lagoon to stabilize, and pumping out annually.

1972-1005
ANDERSON, Earl D.
How To Dispose of Manure and Stay Out of Court
Farm Qtrly. 27 (4): 52-56

All states and Canadian provinces now prohibit discharge to surface or underground waters. Consult the applicable law before starting or enlarging an operation. Note the distances to downwind neighbors. Adequate spreading areas should be owned or held under long-term lease. Suggestions and cost estimates are given for beef, dairy, and swine operations.

1972-1006
ANDERSON, Wayne
PEIA Conferees Hear About Dried Poultry Waste Progress
Feedstuffs 44: 4 Sept. p. 2, 44

The Poultry and Egg Institute of America heard reports from Lynn KLOPFENSTEIN on use of Dried Poultry Waste (DPW) as a soil conditioner, from N. R. CLIZER on its use for refeeding, and from C. C. SHEPPARD on its use for both purposes in England.

CLIZER emphasized the necessity to institute proper control to produce a uniform product and the necessity of coordinating present research to establish a firm basis for securing Food and Drug Administration approval of refeeding.

1972-1007
APPELL, Herbert R. and MILLER, Ronald D.
Fuel from Agricultural Wastes
Bureau of Mines paper pres. at ACS Meeting, New York

The paper deals with the conversion of agricultural wastes to industrial fuel oil. Some basic theory behind the process and the experimental procedure is given. Various agricultural wastes such as corn cobs, corn stalks, rice hulls, pine bark, and bovine manure are considered. Tables for each are provided showing conversion, oil yields, CO consumption, and operating conditions.

The authors suggest that additional research is required in the problem areas of reducing operating pressure, separating the oil product from high-ash-content wastes, and decreasing the molecular weight and viscosity of the product oil.

1972-1008
ARMSTRONG, D. W.
The Use of Animal Wastes as Fertiliser
Jnl. of Agric., So. Australia 75: 178-184

The amounts of manure produced and its composition are discussed. Application rates should not exceed 300 lb of nitrogen per acre to avoid groundwater contamination and other detrimental effects. Application of more than 100 lb per acre is useless. If manure is used for irrigation it should be diluted with water. Odor and runoff can create difficulties.

1972-1009
AUBURN UNIVERSITY Animal and Dairy Sciences Dept.
A Phase of Research in Livestock Feeding
Auburn Univ. 3 p.

After a feeding program of 152 days with yearling cattle fed an ensiled mixture (pH 4.8) containing corn (48 percent), hay (12 percent), and waste (40 percent) on which they had average daily gains of 2.62 lb and received carcass grades of U. S. Choice, the final test was accompanied by a menu listing appetizers, Delmonico steaks, chef's salad, potato boats, rolls and butter, and lemon ice box pie.

1972-1010
BARTH, C. L.
Using Air Intensity Limits in Air Quality Standards
ASAE Paper 72-441 16 p.
Abst: McO & B G-173

Progress with the provision of instrumentation for establishing a quantitative scale of odor intensities is described. Field tests are often marred by adaptation and fatigue. Fourteen odor qualities are listed as a tentative basic classification. State odor regulations are tabulated and attitudes on their desirability are discussed. Nineteen references are listed.

1972-1011
BARTH, C. L.
Laboratory Simulation of Swine Manure Lagoons
Progress Report on OWRR Project No. A-025-SC 17 p. proc.

Anaerobic lagoons have operated successfully in the Southeast for up to ten years. "Success is measured primarily on the basis of convenience and not on the basis of water purification."

Laboratory investigations of the effects of varying loading rates and detention times are reported and published data are tabulated. Tentative conclusions include "the implication that lagoons for solids reduction efficiency should receive loading at rates less than 12 lb V. S./1000 ft^3/day and lagoons for solids storage efficiency should be loaded in excess of 12. . . Longer detention times could be expected to reduce the rate of sludge accumulation and to increase the solids reduction rates found thus far in this study."

1972-1012
BARTH, C. L.; HILL, D. T.; and POLKOWSKI, L. B.
Correlating OII and Odorous Components in Stored Dairy Manure
ASAE Paper 72-950 17 p.

The odor intensity index (OII) is defined as the number of dilutions by one-half that are necessary to reduce the odor to a level that is just detectable. By means of odor panels, the authors sought correlations of OII with one or more of the components: volatile organic acids (VOA), ammonia (NH_3), and hydrogen sulfide (H_2S), commonly present in liquid manure. Six regression equations (in the single variables, VOA with each of the others, and all three variables) were deduced.

1972-1013
BELL, R. G. and ROBINSON, J. B
Handling Milking-Parlor Waste
Canadian Agr. Engrg. 14 (2): 56-58

Forced aeration of milking-parlor wastes, while producing a clarified effluent much more acceptable than the raw wastes, does not produce an effluent acceptable for discharge to streams. "Although a septic tank system is quite capable of handling the volume of waste from a milking parlor, it is unlikely that it can cope with the high strength of, and wasted milk in, milking-parlor effluents." A lagoon would have to be sized as an odor-controlling facility and be pumped out periodically for land spreading. ". . . where the manure is already being handled as a liquid, the most satisfactory alternative would appear to be combining the milking-parlor waste with the manure. . . the watery milking-parlor waste would tend to improve the handling characteristics of the manure."

1972-1014
BERGDOLL, John F.
Drying Poultry Manure and Refeeding the End Product
Proc. Cornell Agr. Waste Mgmt. Conf. p. 289-293

Power costs for a dryer vary with moisture content desired, but should be about $6 to 8 per ton of dried product. Total costs range from $15 to 35 with the largest component often being the transportation of the manure from point of deposit to dryer. The quality of the end product depends on feed, method of drying, and promptness of drying. Daily drying is preferable, and recycling of dried manure with wet incoming manure should be avoided.

The optimum refeed level for laying hens is 10 to 15 percent dried poultry waste (DPW). It may replace an equal amount of corn. "Fair to excellent" gains have been obtained by feeding cattle 25 percent DPW.

1972-1015
BERRY, Joe G.
"You Dry It and We'll Buy It"
Poultry Meat 23: Nov. p. 18

An Indiana firm selling poultry manure dryers will contract to purchase the manure dried. It has been unable to supply the demand at $3 to $3.25 per 50-lb bag retail. Temperatures of 180 to 200°F kill seeds and microorganisms.

1972-1016
BETHEA, Robert M.
Solutions for Feedlot Odor Control Problems -- A Critical Review
Jnl. Air. Poll. Control Assn. 22: 765-771. Disc. p. 771-773

Dr. BETHEA reports on a literature survey on the chemical makeup of odors and possible techniques for their control. Parallels are cited in the rendering industry. He cites 52 references.

"The following methods of control as applied to excreta are discussed in detail with comparative cost and effectiveness data: odor prevention by modification of feed rations; odor reduction by recycle manure feeding and by improved waste handling procedures; odor control by chemical reaction, ozonation, gas washing and scrubbing; and odor elimination by thermal and catalytic oxidation."

The discussers, Thamon E. HAZEN (p. 771-772), and John L. MILLS and John A. DANIELSON (p. 773), stress good housekeeping and the need for realistic cost ranges.

1972-1017
BETHEA, Robert M. and NARAYAN, R. S.
Identification of Beef Cattle Feedlot Odors
ASAE Trans. 15: 1135-1137

Laboratory determinations of the qualitative nature of gases present under various circumstances in the vicinity of a cattle feedlot are reported as are the meagre results of a "frustrating" literature search.

1972-1018
BIELY, Jacob; SOONG, R.; SEIER, L.; and POPE, W. H.
Dehydrated Poultry Waste in Poultry Rations
Poultry Sci. 51: 1502-1511
Abst: W73-03992

Dehydrated poultry waste, with less than ten percent moisture content, was fed at levels of five to thirty percent to chicks, broiler stock, and laying hens in rations calculated to be approximately isonitrogenous (total N) and isocaloric. When the DPW was included in a well-balanced ration, no detrimental effect was observed on the health of the birds. Growth and feed efficiency decreased when the DPW content was increased beyond ten percent. The economics of the over-all operation will require much study. "Even if the poultry industry had to subsidize the production of D.P.W. to make it competitive with other ingredients, it would be justified, since it would allow the poultry men to stay in business with fairly odor-free premises and at the same time contribute to the improvement of the 'quality' of the environment."

1972-1019
BONZER, Boyd
Weed Seeds Not Likely in Poultry Manure
The Farmer 17 Nov 72
Reprinted: Poultry Digest 32: 30 (1973)

Lush weed growth on areas fertilized with poultry manure is due to the manure value on seeds already present. Tests indicated that only velvet weed, of seven weeds tested, survived poultry digestion with ability to germinate (1.9 percent of sample fed).

1972-1020
BRIDSON, Randy
Iowa Beef Processors Researching Confinement Feeding, Recycling Waste
Feedstuffs 44: 14 Aug. p. 35-36
Abst: McD & B F-107

Recycling of feedlot waste into processed animal byproduct (PAB) is receiving careful attention. In two tests reported in Iowa cattle with a 37.25 percent PAB ration consumed more feed and gained faster than control cattle. Many variables remain to be optimized. The PAB used originated in the bottom third of an oxidation ditch.

1972-1021
BUTCHBAKER, A. F.; GARTON, J. E.; MAHONEY, G. W. A.; and PAINE, M. D.
Evaluation of Beef Waste Management Alternatives
Proc. Cornell Agr. Waste Mgmt. Conf. p. 365-384

Design considerations for a feedlot should include 1) feedlot laws and regulations, 2) climatic conditions, 3) location, 4) unique local conditions, 5) design criteria for components in the system, 6) economic considerations, and 7) integration of the various systems into a final plan. The objectives of the research described were to develop design criteria to minimize pollution, facilitate handling of wastes, and minimize costs consistent with effective waste disposal.

Variations of open feedlots and confinement buildings are discussed as are methods of collecting, treating, and disposing (to the land) of wastes. A cost analysis for a 20,000-head feedlot is worked out. Many valuable practical points are raised in this excellent paper.

1972-1022
CANADA ANIMAL WASTE MANAGEMENT GUIDE COMMITTEE
Canada Animal Waste Management Guide
Canada Committee on Agr. Engrg. Paged by sections.

The guide is designed "to bring together the current practices that provide reasonable approaches to handling animal wastes. Emphasis is placed on the use of land as a recycling system." Legislation is summarized by province. Manure management and its utilization in crop production are discussed. Methods of processing animal wastes dealt with are anaerobic lagoon, anaerobic digester, oxidation ditch, mechanically aerated lagoon, dehydration, incineration, and composting.

1972-1023
CLAYBAUGH, Joe
Predrying Manure in the Poultry House
DeKalb Mgmt. News and Views. Sept.
Reprint: Poultry Digest 31: 592

Air moving in the pit under a poultry house 24 hrs per day is effective in removing moisture, thus in reducing odor and fly problems and labor in cleaning the smaller volume of more-easily handled manure which remains. When cleaning, several inches of dry manure should be left to absorb moisture. The savings obtained may exceed the costs.

1972-1024
CONNOLLY, John A. and STAINBACK, Sandra E.
Solid Waste Management: Abstracts from the Literature -- 1965
EPA Pbln. SW-66.1 216 p.

Following the format of the 1964 abstracts [1971-1059], this volume contains eight abstracts on agricultural wastes, numbered 65-0230 through 65-0237, on pages 46-48.

1972-1025
CONNOLLY, John A. and STAINBACK, Sandra E.
Solid Waste Management: Abstracts from the Literature -- 1966
EPA Pbln. SW-66.2c 197 p.

Following the format of the volumes for 1964 and 1965, this volume contains 46 abstracts on agricultural wastes, numbered 66-0193 through 66-0238, on pages 46-59. All but ten of the papers abstracted were presented at the National Symposium on Animal Waste Management of the ASAE at East Lansing, Michigan, 5-7 May, 1966.

1972-1026
CONNOLLY, John A. and STAINBACK, Sandra E.
Solid Waste Management: Abstracts from the Literature -- 1967
EPA Pbln. SW-66.3c 404 p.

Abstracts on agricultural wastes in this volume are numbered 67-0328 through 67-0357. They occur on p. 80-90.

1972-1027
CONNOLLY, John A. and STAINBACK, Sandra E.
Solid Waste Management: Abstracts from the Literature -- 1968
EPA Pbln. SW-66.4c 286 p.

Abstracts on agricultural wastes in this volume are numbered 68-0267 through 68-0329. They occur on p. 53-65.

1972-1028
COOPER, George E.; HINDS, F. C.; and LEWIS, J. M.
The Nutritive Value of Sheep Feces (Abst)
Jnl. Animal Sci. 34: 358

Analyses of feces from lambs on all-concentrate diet, lambs on half concentrate-half roughage diet, and ewes on all-roughage diet showed increasing percentages of cellulose, lignin, and ash as the roughage increased. An ensiled mixture of whole corn plant and ewe feces from an all-roughage diet was not highly acceptable to ewes. Additional corn and soybean meal with 0, 6.25, 12.5, 18.75, and 25 percent feces resulted in consumption adequate for maintenance.

1972-1029
COSTIGANE, William D.; EDWARDS, Douglas H.; FRAIPONT, Delwyn R.;
McCLEAN, Garry R.; PINCHIN, James H.; and YOUNGER, Brian H.
Methane Production from Anaerobic Digestion of Animal Wastes
University of Waterloo, Waterloo, Ontario. 75 p. + 8 unnumbered
appendices

"The purpose of this report is to investigate the nature and magnitude of environmental pollution from farm animal wastes and to design an anaerobic digestion system that stabilizes the waste, thereby reducing its pollutional effect. The destruction of pathogenic organisms and the production of useable products such as a combustible gas and a stable innocuous sludge are ancillary benefits achieved from the process. . . The anaerobic digestion system described in this report is not, at present, considered feasible for animal waste treatment on a small farm due to the high initial equipment cost."

Chapter headings in this well-planned comprehensive report are: Introduction, Characteristics of animal wastes, Digester gas utilization and safety, Sludge utilization and disposal, Microbiology and kinetics of anaerobic digestion, Design of the anaerobic digestion unit, Conclusions, and Recommendations. Sixty references are included.

A 21-page proposal, bearing the same title and carrying the designation WRI Project 2034, has been submitted to the Environmental Protection Service, Environment Canada for building and operating a pilot plant and for conducting other studies.

1972-1030
COUCH, J. R.
Feeding Poultry Manure to Animals
Feedstuffs 44: 31 July p. 24-25, 27
Abst: McQ & B F-106

In a good review of recent research, COUCH indicates that broiler chicks could tolerate five percent of dehydrated poultry waste (DPW). Growth decreased significantly when the percentage was raised to ten and twenty due to low energy content. No effect on egg taste or storage quality was detectable when laying hens were fed ten, twenty, or thirty percent DPW.

DPW was recycled in the same poultry through 14 cycles of 12 days each in some tests. At 12-1/2 percent no adverse effects appeared, but at 25 percent the effects of the low energy content were clearly present. The age of manure at the time of drying is critical, and the method of drying is important. Manure for feed should be dried daily.

Swine showed depressed feed conversion with as little as five percent DPW.

Sheep can obtain up to fifty percent of their total nitrogen intake from DPW without adverse effects. Approximately forty nutritionists agree unanimously that "the best place to use dehydrated poultry waste was in beef cattle rations."

1972-1031
CRAMER, C. O.; CONVERSE, James C.; TENPAS, G. H.; and SCHLOUGH, D. A.
This Bunker Stores Manure
Hoard's Dairyman 117: 875, 884, 885

A bunker-type building with 11-foot walls made of 2-by-6 planking stores manure in northern Wisconsin. It was used two years before a roof was added. Two floor drains lead runoff to a detention pond used as a source of irrigation water. By adding manure only two or three time per week during fly season, enough drying occurs to reduce the fly problem. The bunker has less odor than liquid manure, but the solids when spread should be plowed or disced promptly.

1972-1032
DAVIS, E. G.; FELD, I. L.; and BROWN, J. H.
Combustion Disposal of Manure Wastes and Utilization of the Residue
USDI Bureau of Mines Tech. Prog. Rpt. 46 9 p.

In laboratory-scale investigations at Tuscaloosa, Alabama, it was determined that pre-dried manure would sustain combustion in a fluid-bed reactor and that wet manure can be both dried and burned in a rotary kiln. Weight reductions of as much as 90 percent and volume reductions of 85 percent can be obtained. The residue is suitable as a potassium and phosphorus fertilizer and as a lime soil conditioner. The nitrogen can be recovered as ammonia from the exhaust gases.

1972-1033
DIESCH, Stanley L.
Survival of Pathogens in Animal Manure Disposal
EPA Grant EP-00302-04 Annual Report 39 p. proc.

"The oxidation ditch is probably not a public health hazard in terms of aerosol dissemination of leptospires. However, if the lintospiral contaminated manure slurry is not disinfected in some manner environmental health problems would probably result." There may be a public health hazard from aerosols in the spray disposal of wastes.

1972-1034
DOLL, Raymond J.
Economic Impact of Agricultural Pollution Control Problems
Cornell Agric. Waste Mgmt. Conf. p. 9-16

In 1967 Kansas adopted regulations requiring the control of all runoff from animal feedlots, with a minimum retention of three inches of surface runoff. Since then cattle marketings from large lots in the state have doubled. Regulation is necessary, but it should be soundly planned and flexible for maximum total effectiveness.

1972-1035
DUGAN, G. L.; GOLUEKE, Clarence G.; and OSWALD, William J.
Recycling System for Poultry Wastes
WPCF Jnl. 44: 432-440

This paper describes the pilot plant at the Richmond Field Station, California, in which an integrated sanitation-waste material recycling system which treats wastes, conserves water, and reclaims directly the nutrients in the waste is being tested. In an aerobic phase algal activity or mechanical aeration could be used. If algae are grown a potential 30 to 40 tons (dry weight) of algae per acre of pond per year can be obtained. Algae can be used as a portion of the chicken feed with no noticeable effect of flavor or acceptability of the eggs or on the weight, morbidity, or mortality of the birds.

Cost estimates for a prototype plant are in the range of 1-2 cents/ dozen eggs.

Schematic diagrams and process data are included in the paper.

1972-1036
DUNN, G. G. and ROBINSON, J. B.
Nitrogen Losses through Denitrification and Other Changes in Continuously Aerated Poultry Manure
Proc. Cornell Agr. Waste Mgmt. Conf. p. 545-554

Oxidation ditches studied under winter (11°C avg) and summer (18°C avg) conditions lost about 70 to 80 percent of the input nitrogen with little difference traceable to temperature effect. Ditch velocities were about 1 fps.

1972-1037
EARL, George A., Jr.
Controlling Odors From Manures
Poultry Digest 31: 397-398

Manure should be kept as dry as possible. When spread, it should be plowed or disced under. If spread as a slurry, it should be injected. Avoid spreading on hot, muggy days and in late afternoons or evenings upwind of neighbors. Masking agents may help. Practice good housekeeping.

1972-1038
EDWARDS, J. B. and ROBINSON, J. B.
Changes in Composition of Continuously Aerated Poultry Manure with Special Reference to Nitrogen
Cornell Univ. Conf. on Agr. Waste Mgmt. p. 178-184

Nitrogen beyond the capacity of a crop to utilize it may pollute groundwater or surface water. Thus, according to the circumstances, it may be desired to conserve the nitrogen content of manure or to reduce it drastically before spreading or irrigating. Studies in the laboratory and with an oxidation ditch in Guelph, Ontario, are described.

"From the limited data obtained in this study, the oxidation ditch appears to be a useful device for controlling the ultimate nitrogen content of the manure before land utilization. By encouraging the nitrification-denitrification sequence nitrogen can be removed and, presumably, by inhibiting nitrification, nitrogen could be conserved. Further studies are underway to determine the feasibility of nitrification inhibition in the oxidation ditch."

1972-1039
EICHE, Carl
10 Recommendations to Control Water Pollution
Prairie Farmer 144: 4 Mar. p. 72-73

Application of animal wastes to land is the most practical approach, particularly for small operators, in the opinion of the federal Water Pollution Control Advisory Board. "But the board also wants to consider such promising possibilities as converting animal wastes into fuels, building materials, dry fertilizer, and tires, and recycling these wastes in animal feeds."

Problems are mentioned.

1972-1040
EICHE, Carl
Waste Crisis Alters Hog Man's Disposal System
Prairie Farmer 144: 19 Aug. p. 16-17

The substitution of a manure holding pit for undersized pits under a slotted floor hoghouse solved an overload problem traced to feeding of high-moisture corn.

1972-1041
EICHE, Carl
Wastes Are Valuable
Prairie Farmer 144: 18 Nov. p. 16-17

Huntington Hatchery (Indiana) dehydrates poultry manure for sale as a lawn conditioner. While it has some odor, it has the advantage of not hardening in the bags. Experimental work by Dr. Howard C. ZINDEL at Michigan State University indicates that the dried manure has value as a component of poultry rations. Commercial use for this purpose awaits approval by the Food and Drug Administration.

A hundred birds produce a ton of dried manure per year.

1972-1042
ELAM, F. Leland
Flushing System and Lagoon Eliminate Manure Problem
Hoard's Dairyman 117: 378

A homemade system near Turlock, California, provides for the flushing of a 400-cow dairy barn to a lagoon. A scum cover which formed on the lagoon eliminates mosquitoes and odor. From the lagoon 200 acres of pasture and corn can be irrigated by gravity. "Solids pass out with the liquid."

1972-1043
ERICKSON, A. E.; TIEDJE, J. M.; ELLIS, B. G.; and HANSEN, C. M.
Initial Observations of Several Medium Sized Barriered Landscape Water Renovation Systems for Animal Wastes
Proc. Cornell Agr. Waste Mgmt. Conf. p. 405-410

A barriered landscape water renovation system is an "inexpensive modification of the permeable soil" consisting of a moisture barrier 40 to 60 ft wide located 12 to 30 in. below the original soil surface, recovered to original level, and, in addition, covered in part by a 4 to 6 ft high mound capped with limestone and/or slag. The mound remains aerobic, the refill becomes anaerobic, and the BLWRS provides a long percolation path to remove phosphate, organic matter, and nitrate from wastewaters spread at the top of the mound.

Several are undergoing test at Michigan State University.

1972-1044
FETTEROLF, Jerry
Total Waste Management Systems. . . Help Keep Cattle Healthy and Protect Feeders from Conflicts with Public
Feedlot Mgmt. 14: May p. 16-18
Abst: McO & B F-063

A company feeding 50,000 head of cattle at three locations in western Kansas has developed "a total concept of pollution control, cattle health and protection and efficient waste handling." Keys are the containment of all runoff on land under company ownership, prevention of flooding by interconnecting lagoons and by providing for pumping to evaporating areas from the lowermost lagoon.

Manure is stockpiled then sold to farmers.

1972-1045
FLEGAL, Cal J.; SHEPPARD, C. C.; and DORN, D. A.

The Effects of Continuous Recycling and Storage on Nutrient Quality of Dehydrated Poultry Waste (DPW)
Proc. Cornell Agr. Waste Mgmt. Conf. p. 295-300

Trials whose purposes were to determine the effect of storage on the nutrient quality and to determine the cumulative effects of an extended period of cycles of drying and refeeding on performance are reported. A tabulation of crude protein shows 30.3 percent present after seven days and 18.3 percent after 98 days. In the recycling experiments, performance after 31 cycles was better for the birds fed 12.5 percent DPW, than for those fed none or 25 percent.

1972-1046
FOSGATE, O. T. and BABB, M. R.
Biodegradation of Animal Waste by *Lumbricus terrestris*
Jnl. Dairy Sci. 55: 870-872

Earthworms on a diet of raw dairy cattle feces and water with sufficient lime added to maintain a pH of 7.0 produced 1 kg of worms for each 2 kg of dry fecal matter. The earthworm castings, a loose friable humus type of soil containing three percent nitrogen, provide an excellent greenhouse potting soil weighing half as much as the usual potting soil and providing more flowers on more strongly rooted plants. The earthworm meal, containing 58 percent protein and 2.8 percent fat, is very palatable to domestic cats.

1972-1047
FRIEDMAN, Sam; GINSBERG, Henry H.; WENDER, Irving; and YAVORSKI, Paul M.
Continuous Processing of Urban Refuse to Oil Using Carbon Monoxide
Bureau of Mines paper pres. at 3rd Mineral Waste Utilization Symposium, Chicago, Mar. 14-16

The conversion of urban refuse to oil is discussed and results are tabulated showing operating conditions, oil yield and properties. Preliminary experimental runs were made with an aqueous sucrose solution. Tabulations present the effect of temperature, pressure, and residence time on the process. Preliminary cost estimates are given for conversion of urban refuse and cattle manure to oil.

1972-1048
FU, Y. C.; METLIN, S. J.; ILLIG, E. G.; and WENDER, Irving
Conversion of Bovine Manure to Oil
Bureau of Mines paper pres. at ACS Meeting, New York, Aug.

The authors focus their attention strictly on conversion of bovine manure to oil, excluding all other organic waste sources. The experimental procedure is outlined; results are discussed and shown in tabular form.

A temperature range of 300° to 400°C was used. This resulted in pressures of 2400 to 5300 psi. The effect of using synthesis gas (H_2:CO = 0.9:1) or H_2 in place of CO was investigated, as were catalyst addition and vehicle. Reasonably good oil yields were obtained with the synthesis gas in place of CO. Low operating pressure and a reduced energy requirement for heating were achieved through the use of a high-boiling vehicle and by reducing the water:manure ratio to about 0.25:1. Quantitative results are tabulated showing percent conversion, percent oil yield, and CO consumption as functions of temperature for each reactant gas (H_2 or H_2-CO). For example, with synthesis gas (H_2-CO), conversion was 99 percent, oil yield was 34 percent, and CO consumption was 0.41 g CO/g manure.

1972-1049
GARNER, William; BRICKER, C. E.; FERGUSON, T. L.; WIEGAND, C. J. W.; and McELROY, A. D.
Pyrolysis as a Method of Disposal of Cattle Feedlot Wastes
Cornell Agr. Waste Mgmt. Conf. p. 101-123

Following a general background on pyrolysis, particularly of wood, the authors describe the procedures and discuss the results of tests on three batches of steer manure from steers on different rations and in different housing conditions. Costs would vary with the products sought, these being functions of temperature and pressure.

"The estimated cost/ton of pyrolysing manure (80% moisture) in a feedlot of 40,000 head capacity is $5.60. . . Details of the estimate are presented. . . Particular worthy of note is the fact that fuel oil costs ($2.26/ton) are more than the value of recoverable tars and oils ($1.29/ton)."

The economics of pyrolysis would improve if cattle were fed more roughage (more and drier manure). "Also, as oil and other fossil sources of carbon become scarce, manure pyrolysate may become competitive with crude petroleum and coal tar."

"The pyrolysis process has its own environmental liabilities."

1972-1050
GEHLBACH, Albert E.
Operational Problems of Pork Production Related to Environmental Quality
Proc. Cornell Agr. Waste Mgmt. Conf. p. 263-265

Hauling to croplands is the most popular method of swine waste disposal. Oxidation ditches have a low odor, but a high cost. Operating costs run 80 ¢ to $1.00 per animal marketed. Effluent and sludge must be disposed of. In northern climates lagoons are non-functional in winter.

1972-1051
GILBERTSON, Conrad B.
An Analysis of Beef Cattle Feedlot Designs for Pollution Control
USDA ARS 42-201 8 p.

The relative merits and costs of unpaved, paved, and housed feedlots are analyzed. "High labor requirements for manure management and apparent cattle discomfort may limit development of outdoor paved lots. . . There is little difference between the overall materials cost of paved and unpaved feedlots." Use of an oxidation ditch increases the initial costs of a housed feedlot by about 17 to 20 percent. Costs of electricity for operation are estimated at $17.50 per head capacity.

1972-1052
GILBERTSON, Conrad B.; NIENABER, J. A.; McCALLA, T. M.; ELLIS, J. R.;
and WOODS, W. R.
Beef Cattle Feedlot Runoff, Solids Transport and Settling Characteristics
ASAE Trans. 15: 1132-1134

"Design of a runoff control facility for beef cattle feedlots should be determined by climatic, physical and topographic conditions of the feedlot and by water pollution potential, regulations and the type of farming." Experiments with batch and continuous runoff systems are described and equations for the design of solids removal systems are proposed. The use of barriers in open channels is recommended.

1972-1053
GOLUEKE, Clarence G.
Changing from Dumping to Recycling. Part II: Organic Wastes
Compost Sci. 13: Mar-Apr. p. 20-23

Recycling can occur by 1) conversion to soil, 2) conversion to a feedstuff directly or indirectly, and 3) conversion to useful chemicals by fermentation or by pyrolysis.

Ponding, anaerobic and facultative, and its refinements -- the oxidation ditch, the high-rate pond, the trickling filter, and the activated sludge process are discussed and evaluated.

Anaerobic digestion "is a rather expensive process to use for treating manures. Beef manure is not readily digested. . . Manures with a high nitrogen content such as hog manure containing urine also do not digest well. . ."

1972-1054
GOLUEKE, Clarence G.
Changing from Dumping to Recycling. Part III: Composting and Miscellaneous Processes
Compost Sci. 13: May-June p. 5-7

"Composting is the biological decomposition of organic matter under controlled conditions." Consideration must be given to aeration, moisture content, temperature, carbon-nitrogen ratio, and particle size. Manure can be composted in 8 to 14 days without undue difficulty. A mixture of manure and sawdust or straw makes an excellent compost.

Land disposal may be employed directly if the assimilatory capacity is not exceeded, or may by employed for the sludges produced by the other methods.

Use of organic wastes in animal feedstuffs holds great promise provided that the possibility of bacterial and viral transmission is thoroughly explored, that the concentration of toxic materials is investigated, and that Food and Drug Administration approval is secured.

Pyrolysis "is as yet in the research stage."

Assorted fermentations are under investigation. "At present, the economics of the processes are highly unfavorable."

1972-1055
GOLUEKE, Clarence G.
Composting Perspectives -- Progress Since 1950
Compost Sci. 13: July-Aug. p. 6-8

GOLUEKE reviews the history of composting from early work by HOWARD, VAN VUREN [1949-1004], and others through the "rediscovery" period of the mid-1960's when promoters of machinery and additives built up to disillusionment, to the present where questions remain, but little research on them is in progress. Composting works no miracles, but is often a viable alternative in solid wastes treatment.

1972-1056
GRAHAM, David B.
Public Relations Aspects of Agricultural Waste Management
Cornell Agr. Waste Mgmt. Conf. p. 17-23

GRAHAM, a farmer, advocates intensified study of refeeding. "My personal feeling is that the publicity on ecology in America has provided agriculture with the proper climate for acceptance of animal wastes as a feed ingredient." However, premature blundering by irresponsible feeders could lead to an adverse public attitude.

1972-1057
GRIMM, Alfred
Dairy Manure Waste Handling Systems
Proc. Cornell Agr. Waste Mgmt. Conf. p. 125-144

In a traditional dairy area in Los Angeles County subject to strong urbanization, an analysis was made of costs and environmental effectiveness of a number of possible manure management practices. The methods considered and the costs per cow-year obtained on the basis of the assumptions made are as follows:

Dirt corral dairies:	
Direct disposal to sanitary landfill	$32.90
Dewater solids and dispose	33.83
Dewater solids and compost in aerated pile	27.88
Dewater solids and compost in turned windrow	22.00
(Two composting machines)	39.63
Paved corral dairies	
Liquid flush - direct disposal	$21.06
Liquid flush - collect solids and dispose	22.46
Liquid flush - collect solids and compost	37.51
Scraped corral - dewater and dispose	33.83
Scraped corral - oxidation ditch	44.00
Centralized regional dairy waste handling system	
Dairymen's fertilizer coop (present practice)	$18.59
Aerated compost windrow	24.77
Turned compost windrow	28.92
(Three competing machines)	30.92
	69.42
Heat drying process	49.02
Activated sludge process	64.64
Incineration	78.90
Pyrolysis	57.42
Wet oxidation	48.12

The method of rating pollution potential by a statistical analysis of the evaluations by a panel of experts is discussed.

The numerical values apply only to the particular hypothesis; the methodology has wide application.

1972-1058
GROVES, Wil
Livestock Waste Control Systems
Wallaces Farmer 97: 22 Jan. p. 15

Effective anaerobic lagoons on a 1400-hog farm and at a 700-head cattle feedlot in Iowa are described.

1972-1059
GROVES, Wil
Step-by-Step Plan for Livestock Waste Control
Wallaces Farmer 97: 26 Feb. p. 16-17

The route to be followed by an Iowa farmer in securing technical information, a permit, and financial assistance from six agencies, state and federal, is spelled out.

1972-1060
HALLIGAN, James E. and SWEAZY, Robert M.
Thermochemical Evaluation of Animal Waste Conversion Processes
Paper, 72nd Natl. Mtg. AIChE 21-24 May

On a dry basis cattle manure has a heat content of 4000 to 7500 Btu/lb. That of coal is 12,500.

Thermochemical calculations for conversion of manure to methane gas, oil, and synthesis gas are detailed. On the basis of a manure output of seven pounds of manure (dry) per day from 600,000 cattle, all product streams would have values which total about $9000 per day. The cattle population (600,000) chosen is that within fifteen miles of a point near Hereford, Texas.

Methane gas production would require oxygen costing $4276 per day on the basis of the authors' price assumptions. "As gas prices increase, this process may become feasible at some locations." A considerable amount of further development would be required to make oil production -- which requires 380°C temperatures and 6000 psig pressures -- economically feasible. "The production of synthesis gas suitable for feed to an ammonia plant appears to have the most promise at this time due to the simplicity of the process and the value of the product."

1972-1061
HAMMER, U. T.
The Interaction of Man and Aquatic Ecosystems
Symp. Sask. Crop Pdctn. in Relation to Pollution. Saskatoon.
20 p. proc.

In a broad survey of the causes and proposed cures for rapid eutrophication of lakes in the Saskatchewan River Basin, HAMMER observes that "no particular problem exists with livestock on the range. If, however, they are confined more and more in feedlots in the name of efficiency and profitability, localized problems exist." He observes that regulations on new feedlots are adequate to control runoff and suggests that existing lots be modified if necessary.

He objects to winter spreading of manure on frozen fields followed by washing into streams in the spring thaw.

1972-1062
HARMON, B. G.; DAY, Donald L; JENSEN, A. H.; and BAKER, D. H.
Nutritive Value of Aerobically Sustained Swine Excrement
Jnl. Animal Sci. 34: 403-407

"The aim of the current study was to measure the nutritive value of solid residue collected from aerobically-maintained swine excrement present in an oxidation ditch." It was found to have nutritive value and its taste did not constitute a deterrent to utilization. The residue contained 27.7 percent protein and could replace 1/3 to 1/2 the protein of casein or soybean meal and support similar weight gains in laboratory rats.

1972-1063
HARMON, B. W.; FONTENOT, J. P.; and WEBB, K. E., Jr.
Preference Studies with Rations Containing Broiler Litter and Molasses
Jnl. Animal Sci. 34: 359-360

In three 20-day trials "cafeteria" style yearling steers were offered 0, 5, 10, 15, 20, 25, and 30 percent molasses with 25 percent litter; the same range in molasses with 50 percent litter; and 5, 10, and 20 percent molasses with 25 or 50 percent litter. In all trials 10 percent molasses was the preferred choice. In trial three, 97 percent of the feeding was from a ration with 25 percent litter.

1972-1064
HARMON, B. W.; FONTENOT, J. P.; and WEBB, K. E., Jr.
Digestibility and Palatability of Ensiled Broiler Litter and Corn (Abst)
Jnl. Animal Sci. 35: 265

Non-processed broiler litter, mixed with chopped corn in eight proportions was ensiled (two stages) and fed to sheep. "Apparent digestibility of crude protein was higher for the silages containing litter than for the control silage at both stages of maturity."

1972-1065
HARTMAN, Roland C.
Go After Fertilizer Market
Poultry Digest 31: 66

The poultry industry is warned to intensify its campaign for the fertilizer market. Municipal sewage sludge purveyors are reported to being invading the field. Minnesota Science is quoted: "Among potential dangers in using sewage as fertilizer are harmful bacteria, viruses and nitrates. . . Sewage may also contain heavy metals such as zinc, cadmium, and lead. . . Poultry manure, correctly processed, should not pose any danger from bacteria, viruses, or heavy metals."

1972-1066
HEGG, Richard O. and LARSON, Russell E.
Solids Balance on a Beef Cattle Oxidation Ditch
Proc. Cornell Agr. Waste Mgmt. Conf. p. 555-562

In a test run at the University of Minnesota from 9 July through 24 August, 1971, an oxidation ditch supplied by 36 beef animals on a high-concentrate ration reduced the total solids by 39 percent and the total volatile solids by 44 percent.

1972-1067
HENTGES, J. F., Jr.; SALVESON, R. E.; SIRLEY, R. L.; and MOORE, J. E.
Processed Aquatic Plants in Cattle Diets
Jnl. Animal Sci. 34: 360

Yearling steers remained healthy on a diet of coastal bermudagrass, water hyacinth, or Florida elodea (a plant which grows submerged). Bermudagrass was preferred to elodea, but bermudagrass and water hyacinth were about equally acceptable. The aquatic plants provide sufficient energy but are low in useful nitrogen.

1972-1068
HERRICK, John B.
Animal Waste Reuse
A. I. Digest 20: June p. 16

A feedlot operator should have sufficient land available for land spreading of his wastes. They should not be spread on frozen ground and should be plowed in as spread. The law requires this in Sweden and may here ultimately.

Tests with recycling have indicated that manure from cattle with high grain rations was most effective. Poultry litter gave fair results but it is not recommended. Much nutritional value remains in manure.

Questions of cost, possible disease spreading, and effects of drugs, hormones, and antibiotics require more research.

In a few years' time "it may be your answer."

1972-1069
HODGETTS, Brian
Animal Wastes in the U.S.A.
Agriculture 79: 98-103

This survey of American practice by an Englishman observes that "land spreading is still, of course, generally the cheapest, most efficient and most popular means of disposing of animal manures, but the economic cost of doing this may in some cases be so high as to make the system unattractive."

Aerobic treatment of liquid wastes has advantages; its problems are foaming, sedimentation and high running costs. Aerobic treatment of solids by the 'Bressler' system (fan aeration in pits beneath cages) involves high capital costs. Composting is ineffective on poultry manure alone and, thus, involves blending with some other waste source.

Anaerobic lagoons work admirably in the climate of Southern California with lagoon water being recirculated for flushing.

Nutrient recycling and manure degrading with fly larvae are discussed. Fly larvae hold great promise in that "the activities of the young larvae aerate and successfully deodorize the manure in 2-3 days and remove 50 percent of its moisture. The larvae are allowed to pupate and when dried and ground the pupae may be used as a protein source for the growing chick. The remaining manure may be further dried or pelleted and can be used as a soil conditioner or fertilizer, or even as a feed for catfish. The manure from 100,000 hens is expected to produce between 500 and 1000 lb of pupae meal daily."

1972-1070
HUMENIK, F. J.; SKAGGS, R. W.; WILLEY, C. R.; and HUISINGH, D.
Evaluation of Swine Waste Treatment Alternatives
Proc. Cornell Agr. Waste Mgmt. Conf. p. 341-352
Abst: McQ & B E-303

As a step toward establishing allowable rates of land application, the authors experimented with a single anaerobic lagoon with effluent used for irrigation and with two anaerobic lagoons in series. It would appear that land application may often be limited by the content of nitrogen, sodium, or copper. Copper build-up from swine manure can render forage toxic to sheep.

1972-1071
JAEGER, G. B.; WHELDEN, H. C., Jr.; MUIR, F. V.; and KITTRIDGE, C. W.
Manure Management in Deep Pit Houses (Abst)
Poultry Sci. 51: 1821

Manure must be maintained in a semi-solid state free of objectionable odors. Control of excess moisture requires good cage management. Experiments were conducted on the interception of manure on intermediate drying surfaces.

1972-1072
JOHNSON, Hugh S. and RIDLEN, S. F.
Gases and Odors From Poultry Manure
Poultry Digest 31: 295-296

Manure gases can affect the health and performance of a flock and can cause bird deaths in some situations. Carbon dioxide, ammonia, hydrogen sulphide, and methane are common in poultry operations. Lethal levels may occur when manure is stirred. Daily cleaning or dilution by forced ventilation are the most feasible means of control.

1972-1073
JOHNSON, J. B.; CONNOR, L. J.; HOGLUND, C. R.; and BLACK, J. Roy
Implications of State Environmental Legislation on Livestock Waste Management
Proc. Cornell Agr. Waste Mgmt. Conf. p. 71-81

The legislative provisions and administrative structure for the regulation of livestock production to control resulting water pollution are tabulated for 27 states. Costs to the producer for compliance will vary with circumstances. In all cases, margin of profit is threatened. Producers, consumers, and taxpayers will share the added costs in proportions not yet determinate.

1972-1074
JOHNSON, R. R.
Digestibility of Feedlot Wastes from Typical Southern High Plains Feedlots (Abst)
Jnl. Animal Sci. 35: 268

Sheep were fed rations of 75 percent cotton seed hulls, 25 percent dried feedlot wastes and 60 percent cotton seed hulls, 40 percent dried feedlot wastes. The wastes had a high ash content "presumably of soil origin." "Palatability was not decreased by inclusion of 40% feedlot waste, although digestible organic matter intake was decreased."

1972-1075
JONES, Don D.; DAY, Donald L.; and DALE, A. C.
Aerobic Treatment of Livestock Wastes
EPA Pbln. SW-16rg. 55 p.

This booklet reviews the theory of aerobic treatment, discusses oxidation ditches at some length, and gives criteria for aerobic lagoons -- oxidation ponds, and mechanically aerated lagoons. "Some form of aerobic treatment of livestock wastes appears certain to be used in the future in animal production enterprises. Odor control alone may be sufficient to make it a feasible operation." An oxidation ditch, in addition to providing a nearly odorless operation, has the ability to handle shock loads, requires little attention or maintenance, fits well under a slotted floor, and is reasonably inexpensive.

The effluent may best be used for irrigation.

1972-1076
JONES, P.H. and PATNI, N. K.
A Study of Foaming Problems in an Oxidation Ditch Treating Swine Wastes
Proc. Cornell Agr. Waste Mgmt. Conf. p. 503-515

Foam control methods presently used are the spraying with water jets to break the foam mechanically or the dilution with appropriate liquids to raise the surface tension. Such methods may require water which is unavailable, produce excess contaminated effluent, and require labor. A continuous overflow to carry foam out of the ditch requires weir adjustment and supervision. The effects of various parameters on foam formation are discussed.

The practical solution adopted was the installation of an electronic foam sensor to cut off the rotor motor under predetermined amounts of foam build-up.

1972-1077
KAPPE, David S.
Development of a System and a Method for the Treatment of Runoff from Cattle Holding Areas
Proc. Cornell Agr. Waste Mgmt. Conf. p. 353-363

At a 285-head dairy farm in Maryland wastes from a concrete-paved holding area designed to accomodate 140 cows awaiting milking, in four-hour periods twice per day, are being combined with wastes from the milking parlor and from a dairy processing plant (bottle washing, etc.) for treatment in an extended-aeration modification of an activated sludge plant. Tests will be undertaken with tanks in parallel and in series, with modifications of pH, with a partially anaerobic tank followed by an aerobic tank, etc., to determine peformance and costs under actual operating conditions. The facility was undergoing operational shakedown when the paper was written.

1972-1078
KIESNER, Jack
FDA Awaiting More Evidence Before Okaying Litter as Feed
Feedstuffs 44: 20 Mar. p. 2, 88

Jack C. TAYLOR, addressing the annual Maryland Nutritional Conference, observed that the Food and Drug Administration would need the following information before approving the use of poultry litter as feed: 1) source of raw materials; 2) a stepwise description of the processing, manufacturing methods, and analytical controls; and 3) a description of the end product and its intended use.

Health and safety of animals and man must be assured. Arsenicals are routinely fed to chickens and swine, but not to cattle. The effect on cattle and man must be determined. Copper has caused trouble in cattle.

1972-1079
KLEIN, S. A.
Methane from Anaerobic Digestion
Compost Sci. 13 (4): 31

A summary and statement of conclusions from KLEIN's studies on anaerobic digestion of "as received" refuse includes the statement that "It is recommended that anaerobic digestion be applied only to putrescible organic wastes such as garbage, garden debris, soiled paper, animal manures and agricultural residues."

1972-1080
KLETT, R. H.; HANSEN, K. R.; and SHERROD, L. B.
Sodium Levels in Beef Cattle Finishing Rations as Related to Performance and Concentration in Feedlot Solid-Waste
Texas Tech University, Reports - 1972 - Killgore Beef Cattle Ctr., p. 11-16

One-hundred-eight steers were divided equally into six treatments with three replications of six steers each and fed rations containing 1.0 percent, 0.5 percent, 0.25 percent, 0.125 percent, 0.0625 percent and 0 percent salt (NaCl). Animal performance was measured by 28-day weights, feed consumption, feed conversion by pens, and carcass traits. Sodium (Na) concentration and build-up in the solid waste was measured periodically by sampling the feedlot with a coring device. Sodium concentration in the rations was not significantly related to average daily gain, feed intake, or carcass traits. There was a significantly poorer feed conversion at the 1.0 percent level, but the effect was attributed to animal variations. Data suggested that Na content of feedstuffs in finishing rations provide sufficient levels to meet requirements without supplemental sodium. Sodium concentration in the solid waste was linearly related to Na intake. Levels of Na accumulation in the solid waste appeared to be sufficiently low so as not to be harmful in run-off or to croplands if applied at 10-15 tons per acre every 3-4 years.

1972-1081
KNAPP, George L. (Editor)
Soil Nitrogen Cycle: A Bibliography
WRSIC Pbln. 72-208 306 p.

This is a subcollection of 200 abstracts from Selected Water Resources Abstracts, volumes 1 through 4. An 86-page comprehensive index and a 17-page significant descriptor index enhance the usefulness of the volume.

1972-1082
KOELLIKER, J. K.; MINER, J. Ronald; HAZEN, T. E.; PERSON, H. L.; and SMITH, R. J.
Automated Hydraulic Waste-Handling System for a 700-Head Swine Facility Using Recirculated Water
Proc. Cornell Agr. Waste Mgmt. Conf. p. 249-261

Seven years of cumulative research at Iowa State University have led to the construction of a 700-head swine facility flushed hourly to an anaerobic lagoon, using lagoon effluent for the flushing. Excess effluent is used to irrigate three acres of cropland by sprinklers. Investment of $10 to 15 per hog capacity was required. The nine-year-old anaerobic lagoon has never required cleaning.

1972-1083
KREHER, Henry J.
Operational Problems of Poultry Production Related to Environmental Quality
Proc. Cornell Agr. Waste Mgmt. Conf. p. 311-316

KREHER describes the harassment to which a commercial poultryman in New York State may be subjected by suburbanites to whom manure spreading constitutes a nuisance.

1972-1084
KREIS, R. Douglas; SCALF, Marion R.; and McNABB, James F.
Characteristics of Rainfall Runoff from a Beef Cattle Feedlot
EPA Report EPA-R2-72-061 Corvallis, Oregon vii + 43 p.

Quantity and quality relations for rainfall and runoff from a 12,000-head cattle feedlot at McKinney, Texas, were studied. Normal precipitation is 37 in/yr and class A pan evaporation is 70 to 80 in/yr. Procedures and findings are discussed and tabulated.

Among conclusions reached were that detention in holding ponds reduced dissolved solids concentrations by 90 percent and organic pollution concentrations by 70 percent, accounted for in part by sedimentation and in part by dilution by rainfall on the pond surface. Bacterial counts were higher a day after runoff than they were during the runoff. The quality was unfit for discharge to streams.

It was recommended that open, uncovered cattle feedlots be provided with storage and diversion facilities to prevent runoff to water courses. Surface water should not be permitted to enter feedlots. A series of ponds is desirable. Effluent from the final pond should be treated, perhaps by being spread on land by sprinklers.

1972-1085
KREIS, R. Douglas and SHUYLER, Lynn R.
Beef Cattle Feedlot Site Selection for Environmental Protection
EPA, Environ. Protect. Tech. Series, R2-72-129 39 p.

This is a well organized and clearly presented guide setting forth the basic considerations of site selection. A well chosen example of a site development without and with proper concern for pollution control adds to the value of the presentation. Points covered include regulations with a listing of the responsible agencies in each state. Spatial requirements for pens, runoff diversion and collection structures, ultimate disposal areas, and buffer zones are discussed and tentative formulae are proposed. Topographic features desired are 1) a minimum of land contributing runoff to the feedlot, 2) a slope between two and six percent which will assure drainage without risking erosion, 3) space with suitable slope and deep soils for construction of runoff collection and storage facilities, 4) an area for manure storage which will not contribute to surface or groundwaters, 5) a dry access route with gentle gradients, and 6) a runoff disposal site with mild gradients well away from natural drainage areas. Microclimates, soil and geologic structures, and social considerations are other points discussed.

A bibliography with 55 references is included.

1972-1086
KRONEBERGER, G. F.
Porteous Conditioning of Sludges for Improved Dewatering
AIChE Symposium Series 122, 68: 176-185

This paper outlines the various parts of the BSP Heat Treatment System (Porteous Process) used in conditioning lean sludges so that they can be easily dewatered. A broad, rather than an in-depth, coverage of the topic is given

The main operations of the process include sludge thickening, pressure pumping to 250 psig for introduction to a reactor, direct steam heating and agitation for 20 to 60 minutes, followed by depressurization and dewatering. The process breaks down the gel structure of the fine sludge particles so that bound water can be released. A general flowsheet is shown and discussed. Capacities for the units range from 200 to 9000 GPH. Operating costs and installed equipment costs are shown for capacities of 2000, 4000, 6000, and 9000 GPH. Types of sludge applicable to the process are discussed. Applications of the process to industry are outlined and variations of equipment are described. An important consideration is that heat from the process can be recovered by boilers to provide steam for the process.

1972-1087
KUMAR, M.; BARTLETT, H. D.; and MOHSENIN, N. N.
Flow Properties of Animal Waste Slurries
ASAE Trans. 15: 718-722 [ASAE Paper 70-911]
Abst: McQ & B G-092

This is a report on the physical characteristics of flow of slurries of diluted manure and sawdust in pipelines. The literature is reviewed and 27 references are cited.

1972-1088
LARSON, R. E.; HAZEN, T. E.; and MINER, J. Ronald
Storage of Manure Solids by Forming Soil-Manure Pellets
Proc. Cornell Agr. Waste Mgmt. Conf. p. 201-210

In employing hydraulic transport of manure it is advantageous to remove coarse sediments by screening. Storage is often necessary while awaiting spreading. To inhibit odor, moisture content and/or pH may require adjustment. Mixing with soil and lime and pelleting can accomplish this and produce a material easily handled. Experiments for optimizing the mix of manure, soil, lime, and water are discussed.

1972-1089
LEVI, Donald R.
A Review of Public and Private Livestock Waste Regulations
Proc. Cornell Agr. Waste Mgmt. Conf. p. 61-69

Public regulation is generally by some state agency with water pollution and air pollution usually being under different agencies. In general, tolerance levels are established and a permit system is imposed.

Private regulation is by means of civil lawsuits alleging nuisance and seeking injunction and/or damages. Technicalities are defined and distinguished in the paper. Means suggested for reducing the likelihood of suits are rural zoning, prudent site selection, prior operation, caution in entering contracts, good housekeeping, and compliance with licensing laws.

1972-1090
LIN, Shundar
Nonpoint Rural Sources of Water Pollution
Illinois State Water Survey Circ. 111. 36 p.
Abst: UCOWR Newsletter 33: 13-14 (July 1973)

"Animal wastes in confined areas are the most significant stream pollution sources in rural areas of the state. . . Within current technology the most practical means for controlling, handling and disposing of animal waste in a manner that will minimize stream pollution involve 1) using a feed ration that will lessen the quantity of waste and improve its treatability, 2) preventing uncontrolled feedlot runoff, 3) providing adequate waste storage facilities, and 4) maintaining a controlled program of waste disposal on the land surface."

1972-1091
LOEHR, Raymond C.
Agricultural Runoff -- Characteristics and Control
ASCE Proc. 98: SA 909-925

Soil conservation practices are valuable in controlling pollution in that runoff contains organic matter and chemicals as well as silt. Manure is not a serious pollutant until it reaches surface or ground water. Confined housing, in reducing quantity of diluted manure, reduces pollution hazard. The quality of feedlot runoff is sensitive to the intensity of precipitation, the initial moisture of the manure, and the type of surface, but is not particularly sensitive to the quantity of manure on the lot.

Typical constituent analyses of feedlot runoff and empirical rainfall-runoff relations are cited.

A rational program of pollution control for feedlots consists of using dikes and levees to prevent inflow to the lots and to impound outflow from the lots. Roofs should have gutters, and the roof runoff should be led outside the dikes. Settling basins ahead of combinations of lagoons, oxidation ponds and aerated systems are useful. Evaporation ponds should be used where applicable. Land spreading of solids and irrigation with liquids is advocated. Incorporation of manure into the soil after spreading, and recovery of tailwater are advisable. Avoid spreading on snow or frozen ground, and avoid nitrogen leaching or salt buildup.

1972-1092
LOEHR, Raymond C.
Removal of Phosphorus from Liquid Animal Manure Wastes
Proc. Cornell Agr. Waste Mgmt. Conf. p. 411-427

Phosphorus removal from effluents is desirable to control algal growth. In general, it would seem to be preferable to utilize the phosphorus-removing properties of soil by spreading animal waste effluents on land rather than to attempt chemical removal. In a few cases, such as in disposal of duck wastes on Long Island, treatment may be resorted to. Laboratory studies indicate that the addition of lime or alum may be effective with lime usually being the least costly.

1972-1093
LONGHOUSE, A. D.
Reduction in Moisture and Daily Removal of Wastes from Caged Laying Hens
Proc. Cornell Agr. Waste Mgmt. Conf. p. 173-185

To eliminate ammonia and flies in a windowless poultry house, it is necessary to remove manure daily. The author describes a dryer-conveyor being tested at West Virginia to accomplish this. More complete automation is desired before the operation can be regarded as satisfactory.

1972-1094
LORIMOR, J. C.; MIELKE, L. N.; ELLIOTT, L. F.; and ELLIS, J. R.
Nitrate Concentrations in Groundwater Beneath a Beef Cattle Feedlot
Water Res. Bull. 8: 999-1005
Abst: McO & B G-117

Nitrate measurements have been taken since 1967 at a number of points in the immediate vicinity of a beef cattle feedlot at Central City, Nebraska. The lot is on level ground with moderately permeable soil constituting an unconfined aquifer in which the water table is 5 to 40 feet deep. Dye tests have indicated that monitoring wells are receiving effluent from under the feedlot.

"Groundwater nitrate levels were generally lower down-gradient from the feedlot than they were up-gradient. . . Except for two samples obtained during the 1970 pumping trial, nitrate-nitrogen was well below the U. S. Public Health Service limit of ten parts per million."

1972-1095
LUDINGTON, D. C.; SOBEL, A. T.; LOEHR, Raymond C.; and HASHINOTO, A. G.

Pilot Plant Comparison of Liquid and Dry Waste Management Systems for Poultry Manure
Proc. Cornell Agr. Waste Mgmt. Conf. p. 569-580

Odor control for poultry manure can be accomplished by removing moisture or aerating. Tests run at Cornell on four systems produced the ratings indicated on an odor scale in which ten is very offensive: undercage oxidation ditch 1.1, diffused aeration (forced addition of air to tank containing manure covered with water) 1.1, undercage drying by forced air 3.7, and undercage drying by use of fins 4.4. Costs per dozen eggs for the four methods are given as 2-4, 2.7-3.4, 0.6, and 0.007 cents respectively.

1972-1096
LUTZ, Ron
A Livestockman's Guide to Pollution Laws
Successful Farming 70: Oct. p. 42, 43, 50

Laws are outlined for the states of Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. Addresses of agencies charged with supervision of agricultural pollution in the 12 states are included.

1972-1097
MACKEY, D. R.
Waste is Health Concern
Feedlot Mgmt. 14: May p. 74b

Management procedures recommended to help reduce feedlot pollution problems are:

1. Keep number of animals per pen reasonably small.
2. Keep manure from accumulating.
3. Keep pens slightly moist to hold down dust.
4. Have a good insect control program.
5. Construct runoff basins and collecting pits.

1972-1098
MacMILLAN, Keith; SCOTT, T. W.; and BATEMAN, T. W.
A Study of Corn Response and Soil Nitrogen Transformations Upon Application of Different Rates and Sources of Chicken Manure
Proc. Cornell Agr. Waste Mgmt. Conf. p. 481-494

Greenhouse tests were conducted to determine the maximum rates at which two New York soils would respond well to applications of oxidation ditch residue from chicken manure. The pH was the most critical parameter. The nitrogen fraction was degraded rapidly by microorganisms at all rates of loading. Water pollution by excess nitrates is the limiting detrimental effect of heavy application rates.

1972-1099
MANDER, C. E.
Waste Systems of Beef Cubicle Units
Farm Bldgs. Digest 7 (1): 5-10

A survey of 17 farms in the UK pointed up the importance of keeping uncovered yard area to a minimum to avoid dilution of manure from rainfall. For effective scraping minimize the area involved, avoid dilution, preserve straight lines, and avoid obstacles such as columns. For slurry storage take advantage of natural slopes, use slopes above two percent in drains, and avoid straw and fodder inclusion. Irrigation or lagooning are recommended.

1972-1100
MANTHEY, Earl W.
Manure is Food for Protein
Feedlot Mgmt. 14: Oct. p. 18-22

The process developed by General Electric and being tested at Casa Grande, Arizona, feeds manure to a strain of thermophilic bacteria which convert 1 lb of manure into 1.5 lb of protein. The bacteria will be harvested and dried to an odorless, tasteless powder which will be used as a high-protein feed supplement for cattle and other animals.

Cattle manure was a natural first choice for a test material because of its ready availability, and the consideration that the pollution control aspect would help secure acceptance of the concept.

The test facility will operate on manure from 64 head of cattle and four horses. "No problems are anticipated from the appetite standpoint. . . The organisms are plant life, the manure is their source of energy, and it is the organisms that are harvested for refeeding."

Cost studies and design criteria for a full-scale plant will be obtained.

1972-1101
MARRIOTT, L. F. and BARTLETT, H. D.
Contribution of Animal Waste to Nitrate Nitrogen in the Soil
Proc. Cornell Agr. Waste Mgmt. Conf. p. 435-440

The authors report the measurement of the build-up of nitrate nitrogen at various depths in the soil resulting from the application, at various rates, of cow manure slurry four inches under a sod cover. The results are highly sensitive to weather, especially to temperature and moisture. The maximum acceptable long-term rate of application appears to be "in the range of 500 to 600 lb of N per acre."

1972-1102
MARTIN, John H., Jr.; DECKER, Martin, Jr.; and DAS, K. C.
Windrow Composting of Swine Wastes
Proc. Cornell Agr. Waste Mgmt. Conf. p. 159-172

Composting of swine manure was studied with the objectives of controlling odors, finding a rapid procedure, obtaining large volume reduction, securing a useful end product, and avoiding attracting flies and rodents.

Odors occurred on startup. Increased frequency of turning reduced the duration of odor production. Adulteration of the manure with compost or straw reduced both odor and time to stabilization. The volume reduction and the quality of the end product were independent of the amount of mixing. Composting is considered to be a satisfactory solution to swine waste disposal in New Jersey.

Continuous flow would be preferable to batching, since it would eliminate startup. Daily mixing would be desirable.

1972-1103
MASSIE, John Richard, Jr.
Continuous Refuse Retort -- A Feasibility Investigation
Thesis. MS in ChE, Texas Tech University 54 p.

Most pyrolysis tests reported have been made on municipal refuse, oil shale, or coal. Operation has usually been by batch processes. Midwest Research Institute and WHITE and TAIGANIDES [1971-1260] have reported on tests pyrolysing livestock wastes. "Midwest Research Institute does not believe manure pyrolysis to be economically feasible but they based this on an 80 percent moisture content and a 65 percent thermal efficiency. If the moisture content were reduced by normal evaporation and the thermal efficiency increased, pyrolysis could be economically feasible."

MASSIE reports on four tests in a six-inch diameter pilot retort and concludes that "a retort ten feet in diameter could process 129 tons per day of cattle manure containing 29.1 percent moisture."

Further studies on the Texas Tech University retort are in progress.

1972-1104
McCALLA, T. M.
Think of Manure as a Resource, Not a Waste
Feedlot Mgmt. 14: May p. 10, 11, 68
Abst: McO & B F-062

Nutrients are tabulated for various manures and their use on land to produce crops is mentioned. Other uses of increasing interest are the possible production of petroleum and as portions of the feed ration. The U. S. Bureau of Mines is investigating processes for recovering up to three barrels of petroleum per ton of manure. If all manure were utilized this would provide one-half the U. S. needs for petroleum. Refeeding could use up to sixty percent of the wastes.

Control of water and air pollution can be attained at moderate cost by good design, maintenance, and operation of collecting facilities. Mounding of solids for composting, easy drainage, and provision of windbreaks for cattle protection are recommended.

1972-1105
McCALLA, T. M.; ELLIS, J. R.; GILBERTSON, C. B.; and WOODS, W. R.
Chemical Studies of Solids, Runoff, Soil Profile and Groundwater from Beef Cattle Feedlots at Mead, Nebraska
Proc. Cornell Agr. Waste Mgmt. Conf. p. 211-223

"In 1968, studies were initiated at the University of Nebraska Field Laboratory at Mead to determine the effects of cattle density and slope on possible pollution to surface water, soil profile, and groundwater from beef cattle feedlots. Two systems [continuous-flow and batch] were constructed for removing settleable solids from runoff. This paper summarizes the chemical aspects of different beef feedlot management systems at Mead in the 4-year study."

1972-1106
McFARLAND, J. M.; BRINK, D. L.; GLASSEY, C. R.; KLEIN, S. A.; McGAUHEY, P. H.; and GOLUEKE, Clarence G.
Comprehensive Studies of Solid Wastes Management. Final Report.
Univ. of Calif. Berkeley SERL Rpt. No. 72-3 166 p.

The emphasis of the final report is, as was that of the three annual reports [1970-1029], [1970-1030], and [1971-1106], on garbage disposal with only incidental reference to manure. A chapter on pyrolysis-combustion (p. 107-138) and one on anaerobic digestion (p. 139-151) contain much of value in applications of the same processes to animal waste management. In addition to the annual reports, fifteen special reports were issued during the six-year duration of the investigation.

1972-1107
McQUITTY, J. B. and BARBER, E. M.
Annotated Bibliography of Farm Animal Wastes
Environment Canada Tech. Appraisal Rpt. EPS 3-WP-71-1 viii + 522 +
unnumbered index (about 400 p.)

This monumental volume contains 2352 abstracts of material which appeared (with very few exceptions) between 1960 and 1971. The classification adopted and the number of abstracts in each class is as follows:

A.	Abstracting journals and bibliographies	641
B.	Scientific and technical journals	678
C.	Conference proceedings	351
D.	Books and monographs	58
E.	Government, research centre, and university publications	318
F.	Semi-technical publications	110
G.	Unpublished scientific and technical papers	196

1972-1108
MEENAGHAN, George F.; WELLS, Dan M.; and COLEMAN, Eugene A.
A Systems Approach to Cattle Feedlot Pollution Control
Paper, 72nd Natl. Mtg., AIChE 29 p.

Very simple and relatively low-cost solutions are available for the problem of water pollution caused by cattle feedlots. "Vastly more complex and difficult problems to solve are the air pollution and solid waste disposal problems resulting from conventional feedlot operations."

"Farmers do not generally consider it to be economically feasible to use manure as fertilizer. Hence, about the only option open to most feedlot operators for disposal of solid waste is to provide a large tract of land on which the waste can be stored more or less indefinitely. . . Veritable mountains of manure exist. . . these mountains are frequently ignited by spontaneous combustion, thereby providing an additional significant source of air pollution."

A nearly ideal feedlot, that of the Green Valley Cattle Company at San Marcos, Texas, is described. It has slotted floors over pits cleaned daily, is completely roofed, and provides for irrigation by means of a 2000-gal capacity honeywagon equipped with chisels which dispose of the manure below surface thus avoiding the otherwise inevitable odor and fly problems.

1972-1109
MINER, J. Ronald
Agricultural Wastes [In 1971 Water Pollution Control Literature Review]
WPCF Jnl. 44: 1072-1080

The International Symposium on Livestock Wastes with over 100 research papers highlighted 1971. For 64 references cited, a sentence or two summarizes the contents. An additional sixteen references are listed but not cited. Subject headings in the review are as follows: waste characteristics, cattle feedlots, application to cropland, gas and odor production, animal waste treatment techniques, and reuse of animal manures.

1972-1110
MINER, J. Ronald; BUNDY, Dwaine; and CHRISTENBURY, Gerald
Bibliography of Livestock Waste Management
EPA Environ. Protect. Tech. Series R2-72-101 xiii + 137 p.

This publication contains a listing of 241 journal papers, 425 papers published in conference proceedings, 114 university or government publications, 71 magazine articles, 26 books or book chapters, 15 unpublished papers, and 53 academic theses (945 total listings). An author index and a key word index are included.

1972-1111
MINER, J. Ronald and JORDAN, J. R.
Bibliography of Livestock Waste Management
Midwest Plan Service, Iowa State Univ. MWPS-17 130 p.
Abst: McO & B D-030

This publication contains 45 pages of bibliography with about 20 listings per page of technical journal papers, conference proceedings papers, university or government publications, magazine articles, books or chapters from books, unpublished papers, and theses. An author index and a key word index add to the usefulness of the bibliography.

1972-1112
MUIR, F. V. and WHELDEN, H. C., Jr.
Mobilizing for Coordinated Animal Waste Management (Abst)
Poultry Sci. 51: 1842

Representatives from all agricultural agencies in Maine as well as other groups with an interest in animal wastes have held public hearings and drawn up tentative Maine Standards for Manure Sludge Disposal on land. Coordination throughout New England is being sought.

1972-1113
MULKEY, Lee A.
Animal Wastes in the Southeastern United States -- Water Quality and the Poultry and Catfish Industries

Statement Presented at the President's WPC Advisory Board Meeting at
Lafayette, Indiana Jan. 25 p. proc.

Litter of sawdust, peanut hulls, wood shavings, etc., is used to the extent of some 1.3 billion cu ft/yr in the U. S. It is normally replaced two or three times per year at which time it is spread on grassland, without being plowed in, on which cattle graze. The application rate is usually controlled by allowable nitrogen loading Turkeys are raised on open range after their first few weeks. Drainage and retention facilities similar to those required for cattle feedlots are recommended.

Water in which catfish are raised commercially should be recycled, solids should be removed, ammonia should be converted to nitrates, and reaeration should be provided. Ultimate disposal should be by irrigation.

1972-1114
MULLIGAN, Thomas J. and HESLER, J. C.
Treatment and Disposal of Swine Waste
Proc. Cornell Agr. Waste Mgmt. Conf. p. 517-536

Quantities and characteristics of swine wastes are discussed. The governing chemical relations for oxidation ditches, anaerobic lagoons, aerobic lagoons, and oxidation ponds are derived and laboratory data are presented. Disposal of liquid wastes may be by spray irrigation on cropland or, if the climate permits, from evaporation ponds. Sludge should be spread in thin layers and plowed under.

1972-1115
MURPHY, L. S.; WALLINGFORD, G. W.; POWERS, W. L.; and MANGES, H. L.
Effects of Solid Beef Feedlot Wastes on Soil Conditions and Plant Growth
Proc. Cornell Agr. Waste Mgmt. Conf. p. 449-464

An investigation, of which the results "are far from conclusive," indicates that large applications of solid wastes from confined beef cattle can depress yields of irrigated corn silage. The detrimental effects may, however, apparently be reversed by continued cropping and adequate infiltration. "The studies at this location [Pratt, Kansas] are being continued."

1972-1116
NATH, K. R.; DARFLER, J. M.; and BAKER, R. C.
Effect of Waste Management and Egg Processing on the Flavor of Cooked Eggs (Abst)
Poultry Sci. 51: 1843-1844

Methods of waste management studied included the oxidation ditch, forced air drying in the pit, under-cage drying of droppings on slats, diffused aeration ditch, and anaerobic deep water pit. Odors from the oxidation ditch were least and from the anaerobic pit were strongest. No taste difference was detected.

1972-1117
NATZ, Daryl
Progress Reported in Handling Animal Wastes, Recycling in Feed
Feedstuffs 44: 14 Feb. p. 2, 53

The author reviews the Cornell University 1972 Conference with emphasis on the papers dealing with refeeding. BERGDOLL's [1972-1014] recommendation of feeding dried poultry waste from layers (which are fed few antibiotics or other drugs) to beef cattle is cited in particular.

1972-1118
NESHEIM, M. C.
Evaluation of Dehydrated Poultry Manure as a Potential Poultry Feed Ingredient
Proc. Cornell Agr. Waste Mgmt. Conf. p. 301-309

"The metabolizable energy content of the poultry waste is perhaps the best single overall measure of its potential value as feed ingredient." Laboratory experiments for its determination are described. While acceptability is good, chickens compensate for the reduced energy content by eating more and producing more manure.

1972-1119
NIELSEN, Darwin B. and OLSON, P. Parry
Costs of Controlling Feedlot Surface Runoff
Utah Farmer-Stockman 92: 5 Oct. p. 10-11

Of the 31 feedlots in Utah capable of handling 1000 head or more, 26 were assessed in a study of runoff potential. It appears that an expense of 18 ¢ per head fed would be involved in correcting runoff conditions. Of the lots, 12 had no runoff problem, 6 needed minor improvements, 5 needed major improvements, and 3 would find it more economical to relocate.

1972-1120
NIGHTINGALE, H. I.
Nitrates in Soil and Ground Water Beneath Irrigated and Fertilized Crops
Soil Science 114: 300-311

An area of 334 sq mi in Fresno County, California, was studied intensively for nitrates beneath irrigated and fertilized crops. The fertilizers used included steer and chicken manure. "No harmful effects, from the health standpoint, will be encountered even if present fertilizer practices are continued. . . Continued uncontrolled 'suburban' expansion with its septic tank systems and a snift in agricultural production from crops (grapes, etc.) with low N requirement to truck and orchard crops with higher nitrogen requirements may be a cause for concern."

1972-1121
OSTRANDER, Charles E.
Soil Injection of Poultry Manure to Control Odors and Prevent Runoff (Abst)
Poultry Sci. 51: 1847

Most soil injection equipment has no rate-of-flow control. In such cases, speed of travel must be closely regulated. A minimum of 60 horsepower is advised.

1972-1122
OSWALD, William J.
Regenerating Poultry Manure
44th Ann. Rural Electric Conf., Davis, Cal. 6 p. proc.

OSWALD reports on experiments with "closed system" regeneration of poultry manure by flushing the droppings through a grinding and separation system and thence through a settling tank. The supernatant flowed to an algae pond where oxygenation occurred through photosynthesis and/or aeration. The algae produced in photosynthesis were harvested by means of a continuous centrifuge and used as a component in the chickens' diet.

"It is estimated that the cost of operating a system involving photosynthesis could be as much a two cents per dozen eggs. The value of recovered nitrogen was not included in this cost estimate, but could be as much as three cents per dozen eggs where sunlight is adequate and land inexpensive. The cost of aeration without photosynthesis is also estimated to be about two cents per dozen eggs."

1972-1123
PARK, William R. and ELLINGTON, Gary
New Waste Management System for Confined Swine Operations
Feedstuffs 44: 21 Aug. p. 36-37

A 1000-hog operation in Missouri has been successful in disposing of wastes into a concrete tank 20 ft by 40 ft in plan and 13 ft deep provided with a properly designed mechanical aerator. Overflow goes to a settling-evaporation tank. The resulting humus is spread on land. Costs are about $1 per hog handled.

1972-1124
PARSONS, Robert A.
Manure Holding Pond Odor Control
Poultry Digest 31: 386 Credited to Engineer's Notebook, 30 Mar 72

Sprinklers or floating aerators are recommended for odor control on overloaded ponds. "For 10,000 hens, an aerator that puts 60 to 90 pounds of oxygen daily into the pond is suggested."

1972-1125
PERSON, H. L. and MINER, J. Ronald
An Evaluation of Three Hydraulic Manure Transport Treatment Systems, Including a Rotating Biological Contactor, Lagoons, and Surface Aerators
Proc. Cornell Agr. Waste Mgmt. Conf. p. 271-288

Three systems of treatment, all with recirculation of effluent for gutter flushing, were installed in eight swine buildings at Iowa State University. Performance and effectiveness are discussed.

1972-1126
PRATT, Theodore B.
Dairy Waste Goes Full Cycle in Research
Sunshine State Agr. Rsch. Rpt. 17: July-Aug. p. 10-11

Studies on the feasibility of spraying dairy wastes over the land, including uptake of the nutrients by soil and water, yield of different crops, and movement of nutrients and salts in the soil are in their third year at Hague, Florida.

1972-1127
PRICE, Fred
Dried Poultry Waste As Feed
Poultry Digest 31: 248-249

In European practice poultry manure is dried at lower temperatures and the exhaust gases are often run through an afterburner. Both practices reduce odors.

Drying costs of $6 to $37 per ton have been reported. Protein contents range from three to 30 percent with low protein content accompanying high-temperature drying and drying of old manure.

The value of DPW in the poultry ration is about $18 per ton. It may be more valuable for ruminants than for poultry since ruminants can convert urea as uric acid to body proteins. Poultry can not.

1972-1128
RICHARDSON, Len
Finally a Creative, Profitable Solution to Age Old Waste Problem
Big Farmer 44: Mar. 2 p.

Land disposal of hog, cattle, and urban sludge in the right proportions has eliminated odors in the operation of a project at Richmond, Illinois. Corn yields are reported to have increased from 40 bu to over 100 in three years.

1972-1129
RIEMANN, Udo
Aerobic Treatment of Swine Waste by Aerator-Agitators ("Fuchs")
Proc. Cornell Agr. Waste Mgmt. Conf. p. 537-543

In an experimental plant in Kiel, Germany, undiluted liquid pig manure is treated in a battery of three tanks in series. Each tank has a motor-driven impeller providing aeration. Decomposition would require lengthy, and uneconomic, aeration. Some odor and considerable foam occurs. The fertilizer qualities of the effluent are somewhat better than those of raw liquid manure.

1972-1130
ROBBINS, Jackie W. D.; HOWELLS, David H.; and KRIZ, George J.
Stream Pollution from Animal Production Units
WPCF Jnl. 44: 1536-1544

Analyses of quality of runoff from hog lagoons, of streams into which animal manure had been dumped directly, of streams draining watersheds on which land spreading had occurred, and of a stream draining agricultural land free of livestock are reported. All sites were in North Carolina.

It was concluded that anaerobic lagoons were unsatisfactory as a sole treatment for swine wastes where precipitation exceeds evaporation. The lagoons functioned mainly as traps with a limited amount of treatment beyond sedimentation. Direct dumping into streams causes excessive pollution. Land spreading, observing reasonable precautions, is effective. Natural pollution from agricultural land is often high even in the absence of livestock. The state of the art is indeed primitive. Meaningful tests are required. At present total organic carbon would appear to be the most meaningful single parameter for quality of animal waste runoff.

1972-1131
ROBINSON, J. B.
Manure-Handling Capacity of Soils from a Microbiological Point of View
CSAE Paper No. 72-210 18 p.
Abst: McO & B G-160

The criterion for handling capacity of a soil may be taken to be "the ability of the soil microflora to assimilate waste without permitting excessive leakage of nutrients and other undesirable components from the system." This ability is affected by temperature, moisture content, degree of aeration, pH, and initial microbial population. The components of most concern are carbon, phosphorus, nitrogen, and pathogenic organisms. Of these, nitrogen is usually the most critical. Due to the complexities of microbial conversions of nitrogen in mineralization, nitrification, and denitrification generalizations are frequently erroneous and many contradictory results have been reported in the literature.

1972-1132
ROGERS, Charles J.; COLEMAN, Emile; SPINO, Donald F.; PURCELL, Thomas C.; and SCARPINO, Pasquale V.
Production of Fungal Protein from Cellulose and Waste Cellulosics
Environ. Sci. and Tech. 6: 715-719

"Fungal protein, comparable to cereal grain in chemical composition, containing all of the essential amino acids, was produced by fermentation of waste cellulosic substrates." Of the various processes tested to increase the susceptability of cellulose to biodegradation, only photochemical treatment proved to be significant. The processes studied are discussed and 23 references are cited.

1972-1133
ROSS, I. J.; BARFIELD, B. J.; and HAMILTON, H. E.
Critical Waste Problems Ahead
Livestock Breeder Jnl. 15: July p. 270, 272, 274

Soil disposal is the most widely used and perhaps the best method of animal waste disposal. Fertilizer values are obtained. A variety of microbial digestion systems exist. Drying to obtain a "specialized organic fertilizer" may be accomplished by several means. Deep well disposal has been reported in the popular press without details. Research is being conducted in many forms of recycling.

1972-1134
SATTERWHITE, Melvin B. and GILBERTSON, Conrad B.
Grass Response to Applications of Beef-Cattle Feedlot Runoff
Proc. Cornell Agr. Waste Mgmt. Conf. p. 465-480

Testing at nine field plots near Mead, Nebraska, and in greenhouses indicates that the chemical quality of cattle feedlot runoff can vary from year to year. That of 1970 could be applied at depths of two inches or more per week to grass vegetation; that of 1969 was toxic. Tolerances vary with crops irrigated, with climatic and edaphic conditions, and with number of applications during the growing season.

1972-1135
SAVERY, C. William and CRUZAN, Daniel C.
Methane Recovery from Chicken Manure Digestion
WPCF Jnl. 44: 2349-2354

Tests on an experimental anaerobic digester for the production of methane gas from chicken manure are reported. Calculations indicate that a 60,000-chicken unit would supply enough methane to be self-sufficient in its total electricity requirement, but at a cost six times that of its present supply. Improved technology and the impending shortage of natural gas should reduce the adverse cost/benefit ratio. "The incentive for development of methane production as a poultry by-product will most certainly be great when poultry emissions, odor, and wastewater are subjected to controls. It is recommended that preliminary designs of poultry production facilities incorporating alternative types of pollution controls and total energy systems fueled by anaerobic digestion of chicken manure be performed."

1972-1136
SAYLOR, W. W. and LONG, T. A.
Nutritive Value of Ensiled Animal Wastes (Abst)
Jnl. Animal Sci. 35: 288

Tests are reported in which cornfield residue, oat straw, and poultry manure or cow manure were ensiled on a 40:60 fresh manure basis. NaOH, KOH, or NH_4OH was added at a level of four percent. Crude protein was significantly higher for the poultry manure than for the cow manure. Both had significantly higher crude protein than control rations without manure.

1972-1137
SCHLESINGER, M. D.; SANNER, W. S.; and WOLFSON, D. E.
Pyrolysis of Waste Materials from Urban and Rural Sources
Proc. 3rd Mineral Waste Utilization Symposium p. 423-428

This paper describes the process of pyrolysis on municipal, industrial, and agricultural wastes, showing equipment involved, expected yields, and the economics of each.

"Municipal, industrial, and agricultural wastes can be converted to gas, liquid, and solid fuels by pyrolysis. These fuels can be burned cleanly in contrast to the complex combustion of the raw refuse. The process is thermally self-sufficient usually from the gas produced. Energy in the feed is almost all recovered in the product, depending on the feed composition. For municipal refuse, typical recoveries are about 85%; they are even higher for more selective feed stocks such as scrap tires or plastics. Moisture in the feed can affect the product distribution by reaction with the hydrocarbons formed and by participation in the water gas shift reaction.

"Typical waste materials that are available in large quantities and have been pyrolyzed include scrap tires, municipal refuse, wood waste, battery cases, sludge, and manure. Properly designed units should vent no offensive products to the environment. Residue sent to landfill would be sterile and, in most cases, would be only a small fraction of the original volume. Preliminary estimates indicate that the cost will be considerably less than for disposal by other means.

"Although there are still many unanswered questions, the data reported here give an indication of the anticipated processing conditions and the products recovered. Some of the questions concern the yields that would be obtained in a continuous plant operating at equilibrium conditions, the control of moisture in the pyrolysis zone, and the preferred design of the pyrolysis unit."

1972-1138
SCHLESINGER, M. D.; SANNER, W. S.; and WOLFSON, D. E.
Energy from the Pyrolysis of Agricultural Wastes
Bureau of Mines paper pres. at ACS Meeting, New York Aug. 29.

The technique of pyrolysis as applied to bovine manure, crop wastes, and wood wastes is discussed. Pyrolysis is the heating of a material to a high temperature in the absence of air. Results for each case are tabulated showing operating temperature, feed and product analyses, and yields. The effect of moisture in the feed on the product composition is considered.

1972-1139
SCHUSTER, Lee R.
Treatment of Swine Wastes
Proc. Cornell Agr. Waste Mgmt. Conf. p. 267-270

SCHUSTER reports on modification of an existing facility to comply with the toughest proposed federal legislation and to remain in business in a location with a rapidly increasing population.

A tank 20 ft x 40 ft x 13 ft (three feet freeboard) with oxygenating equipment to "turn over" the tank every 4.7 minutes was installed. A preliminary cost tabulation indicates that about $1.00 per hog will be added with no compensating income.

1972-1140
SCOTT, Milton L.
Second Thoughts about Recycling Poultry Wastes
Egg Industry 5: May p. 52, 54

Dried poultry waste has a low energy content. When used in a poultry ration its value is primarily for phosphorus. Viewed as a manure disposal method it may be uneconomical since only a decreasing percentage of the total manure produced can be refed to the same flock.

An editor's note with the article invites comparison with results reported from Michigan State [1972-1190].

1972-1141
SHINDALA, Adnan and SCARBROUGH, James H.
Evaluation of Anaerobic Lagoon Treating Swine Wastes
ASAE Trans. 15: 1150-1152

Studies at a swine-producing facility in Mississippi which utilized slotted floors over a pit, from which the overflow moved by gravity to a single-cell anaerobic lagoon, established that the pollution-potential of the waste was reduced significantly but by no means eliminated. Odor problems arose. It is recommended that an anaerobic lagoon be regarded as only a first step in a waste treatment system.

1972-1142
SIDWICK, J. M.
Cattle Market Wastes
Water Poll. Control 71: 533-538 Disc. 538-539

Loads from cattle markets, including the results of washing down the trucks, often find their way to municipal treatment plants in the UK. The variations in loads attendant upon the short periods of operations of the markets and the intractability of much of the manure and straw to sewage-plant biological treatment are detrimental to good operation.

Bedding straw should be removed thoroughly before hosing down; high-pressure low-volume jets should be employed; fine screens protected by grates should be employed. The paper lists 34 references.

Discussers suggested lagoons at the market with supernatant flowing to the treatment plant, and oxidation ditches.

1972-1143
SINGH, Ram Bux
The Bio-Gas Plant: Generating Methane from Organic Wastes
Compost Sci. 13: Jan-Feb. p. 20-25
Abst: W73-04157

Methane gas is very similar to natural gas in its composition. A well-designed plant will have a life expectancy of about 25 years. South African, French, and Indian installations are described.

Design considerations are treated at length.

1972-1144
SINGH, Ram Bux
Building a Bio-Gas Plant
Compost Sci. 13: Mar-Apr. p. 12-16

Instructions are given for building five methane producing plants of differing capacities and complexities.

1972-1145
SMITH, L. W.
Recycling Animal Wastes as a Protein Source
Proc. Symp. Alternate Sources of Protein for Animal Production
Blackburg, Va. 1 Aug 72 Publication pending.

This review, of which the typed manuscript is 48 pages long with the last 14 constituting a list of references, discusses the use of animal waste as a protein source for various classes of farm animals relative to the diversity of nitrogen compounds in animal waste and examines some animal recycling systems for efficient utilization. "Under the large confinement systems (caged layer operations and beef-feedlots), collection is a minor problem and an incentive exists for considering animal waste as a protein source." Analyses of manure and litter for various classes of nitrogen content are reported and the effectiveness of these for ruminants and non-ruminants is discussed.

The literature on the feeding of caged poultry manure, beef feedlot manure, poultry litter, swine manure, and dairy cattle manure is reviewed in a manner similar to that in chapter V of this report. Poultry litter is the preferred source of manure-based protein, and ruminants are able to make the most effective utilization of a manure component in their diet. "Methods of handling and processing animal waste for feeding can result in adverse effects on its chemical composition and thus possibly on nutritive value."

1972-1146
SMITH, L. W. and CALVERT, C. C.

Dehydrated Poultry Waste in Rations for Sheep (Abst)
Jnl. Animal Sci. 35: 275

Feeding tests in which twelve wethers participated indicate that the use of dried poultry waste as a source of crude protein produced average daily gains at least 90 percent as great as those from soybean oil meal.

1972-1147
SOBEL, A. T.
Undercage Drying of Laying Hen Manure
Proc. Cornell Agr. Waste Mgmt. Conf. p. 187-200

Rapid drying of chicken manure eliminates the opportunity for volatile compounds, responsible for much of the odor, to develop. Drying also reduces the weight and volume of manure to be handled.

Laboratory and field tests of systems of fins and/or screens and of forced-air drying systems are described and the results are tabulated.

1972-1148
SOMMERFELDT, Theron G.
Environmental Quality of the Oldman River in the Lethbridge-Taber Area
Water Users' Conference, Lethbridge, Alta. 13-14 Oct. 15 p. proc.
Accepted for publication in Jnl. of Environ. Quality

Sampling of soil near Alberta feedlots and of the Oldman River and some of its tributaries indicates that reports of pollution from feedlots may be exaggerated. Immediately adjacent to the lots high concentrations of nitrate nitrogen, available phosphorus, and potassium are encountered but these drop off rapidly in soil and groundwater within 400 feet. "There was no measurable evidence of nitrate pollution of the nearby surface waters." A pollution potential is, however, present.

1972-1149
STATE OF IOWA DEPT. OF ENVIRONMENTAL QUALITY
Rules and Regulations: Confined Feeding Operations
Water Quality Commission Release CP-B24136 4 p.

The required facilities under normal conditions include "terraces or retention basins capable of containing four inches of surface runoff from the feedlot area, waste storage areas, and all other waste contributing areas." Settling basins shall be employed and the wastes trapped therein "shall be disposed of as soon as practicable to insure adequate retention capacity for future needs."

Storage periods of 120 to 180 days may be required. "Other methods of water pollution control shall be permitted where the department determines that effective results will be obtained. . . If waste treatment facilities consist only of lagoon type structures there shall be a minimum of two such structures for series operation."

1972-1150
STEFFGEN Fred W.
Project Rescue -- Energy from Solid Wastes
USBM Pittsburgh Energy Research Center

The author discusses conversion of various types of solid wastes (including manure) to fuel oil, to fuelgas (by pyrolysis), and to pipeline gas (essentially methane). The conditions for each reaction are given along with product yields and compositions. A sketch of equipment is included and also a graph showing potential fuel oil supply available from organic wastes.

1972-1151
STEPHENS, E. L.; SHIRLEY, R. L.; and HENTGES, J. F.
Digestion Trials with Steers Fed Aquatic Plant Diets
Jnl. Animal Sci. 34: 363

The mean apparent absorption percentages for oxalates, tannins, and nitrates and the mean net retention of minerals from diets of which 33 percent consisted of coastal Bermudagrass, hydrilla, or water hyacinth are listed. Wide differences occurred among the three plants.

1972-1152
SWEETEN, John M.
Animal Waste Management in Texas
Memo AENG 6, Agric. Ext. Serv. Texas A & M 10 p. mimeo.

Beef feedlots account for 65 percent of the animal manure (dry weight basis) in Texas. Of the total tonnage, 70 percent is from lots which do not contribute to surface runoff under storms of less than once-in-25-years frequency. Other lots are being upgraded toward this goal. Land disposal provides fertilizer and soil conditioning benefits. No salt build-up occurs with application rates below 300-900 tons/acre. "To summarize, land disposal of solid beef feedlot wastes at rates consistent with sound agronomic practice gives benefit-cost ratios of about 2:1 or 3:1." Other methods cited are conversion to a protein source by thermophilic bacteria (GE - Casa Grande, Arizona), conversion to building materials by mixing with glass and heating at atmospheric pressure to 300-400°C (Montford - Greeley, Colorado), conversion to fuel oil at 300-400°C and 3000-4000 psi, refeeding as a fermented mixture of manure and hay, and pyrolysis with ammonia recovery.

Turkey feedlots contribute to water pollution. It is usual in Texas to move the pens rather than the manure, utilizing the fertilizer value of the manure where it falls.

Caged layers produce a high-nitrogen waste. Dehydration and refeeding appear promising. SWEETEN urges a cautious approach to this solution.

Broiler manure has value as a fertilizer and in cattle feed rations.

For dairy cattle and swine, liquid manure handling is usual. Odor problems arise. Lagooning provides little economic return. Slurry irrigation by pipeline and spray nozzle or by storage pit and honey wagon is recommended.

1972-1153
TAIGANIDES, E. Paul
New Waste Treatment System is Used for Hogs
Amer. Farmer 47: Feb. p. 6-7

Ohio State University is testing an installation which flushes animal buildings thus avoiding build-up of noxious gases and automating manure removal. Solids are removed by screens, digested aerobically, and stored for convenient spreading. Liquids are treated in an oxidation ditch and reused for flushing. Provision for chlorination is included in case of disease outbreaks. Initial cost was $40,000. Further work should reduce this to one-half or one-third that amount.

1972-1154
TAIGANIDES, E. Paul and WHITE, Richard K.
Automated Handling and Treatment of Swine Wastes
Proc. Cornell Agr. Waste Mgmt. Conf. p. 331-339

A 500-pig unit at Botkins, Ohio, was opened on 22 Apr 71 in which recycled water is employed for flushing. Solids are removed by screening, digested aerobically, stored, and pumped to cropland. Liquids are treated in an oxidation ditch.

Performance for the first 36 weeks is reviewed.

1972-1155
THOMAS, J. W.; YU, Yu; TINNIMITT, P.; and ZINDEL, Howard C.
Dehydrated Poultry Waste as a Feed for Milking Cows and Growing Sheep
Jnl. of Dairy Sci. 55: 1261-1265

In feeding tests at Michigan State University milk cows were fed 23 percent of their total protein and 11 percent of their total dry matter in dehydrated poultry feces. Sheep were fed 61 and 90 percent of their total protein and 25 and 50 percent of their total ration from the same source. "When the dehydrated feces cost $20/908 Kg, then feed cost per unit gain was similar to that of control lambs. Results indicate the feasibility of using relatively large amounts of dehydrated caged layer feces as a nitrogen and energy source for and lambs."

1972-1156
THORNBERRY, Fredrick D.; GROOMS, Randall D.; and YOUNGBLOOD, Samuel R.
Broiler Litter as a Winter Cattle Feed in East Texas (Abst)
Proc. Assn. Southern Agr. Workers 69: 221

Litter may be more valuable as a winter feed ingredient than as a fertilizer. Heifers gained 1.21 lb/day at a feed cost of 14.5 ¢/lb with a diet based on 1460 lb of broiler litter (pine shavings), 440 lb of ground milo, 125 lb of molasses, 1 lb of vitamin A supplement, free choice salt and bone meal, and 130 bales of grass hay. They "were in excellent physical condition when turned on spring pasture."

1972-1157
TINNIMIT, Parnich; YU, Yu; McGUFFEY, Kenneth; and THOMAS, J. W.
Dried Animal Waste as a Protein Supplement for Sheep
Jnl. Animal Sci. 35: 431-435
Abst: W73-04449

Dehydrated feces fed to sheep at 20 to 80 percent of the ration received excellent acceptance. Goats refused it. The feces furnished 40 to 90 percent of the nitrogen in the ration. The nitrogen retention on the feces ration was 18 to 72 percent. On a soybean ration it was 16 to 65 percent.

1972-1158
UNITED KINGDOM MINISTRY OF AGRICULTURE, FISHERIES AND FOOD
Farm Waste Disposal (Revised)
U. K. Ministry of Agriculture, Fisheries and Food. Short Term
Leaflet 67 24 p.

This is a brief, very practical guide for British farmers to aid them in selection of an effective method of waste disposal. Legal regulations, health hazards, and standards of personal and animal safety are discussed. Surface aerators are highly regarded since they "have the advantage that they can be farmer installed, they can be above ground situations contained completely in tanks or butyl lined lagoons. They are relatively easy to maintain. . ." Even in the generally moist British climate evaporation is an important design consideration. Land disposal and conventional sewage treatment are the only means suggested. "In practice few farmers are able to discharge their drainage into public sewers and the indications are that this facility is unlikely to be offered more widely in the future."

1972-1159
VARGHESE, S. K. and FLEGAL, Cal J.
The Effects of Continuous Recycling Dried Poultry Waste in Laying Hen Diets on Trace Minerals Found in Various Tissues (Abst)
Poultry Sci. 51: 1882

After 23 cycles with 0, 12.5, and 25 percent replacement of corn by DPW (weight basis), investigations indicated that accumulations of arsenic, mercury, copper, and zinc in the tissues, feces and eggs were "not appreciably altered."

1972-1160
VETTER, R. L.; CHRISTENSEN, R. D.; FRANKL, Gerald; and MASCH. W. R.
Feeding Value of Processed Animal Waste Nutrients (Abst)
Jnl. Animal Sci. 35: 1093

Processed animal waste nutrients (PAWN) from an oxidation ditch were fed to steers in three tests up to a maximum amount of 6.8 Kg/steer-day. No observable effects appeared in carcass grade, yield, or health-related factors. A tasting panel was well impressed with the flavor of the meat.

1972-1161
VOGEL, John
EPA Proposes Livestock Waste Rules
Prairie Farmer v. 144. 18 Nov. p. 9-10

Hearings are announced for several places in Illinois on a proposed permit system for new or modified livestock facilities handling more than 100 animal units. An animal unit is defined as 1000 lb of live animal on the premises for one year. Existing facilities must meet the following requirements:

(1) A curb, diversion dike, or wall must be provided to prevent outside surface water from flowing through.

(2) Storage structures capable for storing six months' manure must be provided.

(3) Retention basins or storage ponds with 120 days' capacity must be provided.

(4) Manure may not be applied within 200 ft of any stream nor on frozen land with slopes in excess of five percent.

Costs of complying are discussed.

1972-1162
WEEKS, M. E.; HILL, M. E.; KARCZMARCZYK, S.; and BLACKMER, A.
Heavy Manure Applications: Benefit or Waste?
Proc. Cornell Agr. Waste Mgmt. Conf. p. 441-447

For conditions similar to those tested in Massachusetts there is little economic advantage to exceeding manure application rates of twenty tons per acre. However, applications of up to 600 tons per acre of cattle manure "should not adversely affect crop growth or yield."

1972-1163
WEISS, Alvin H.
Conversion of Solid Waste to Liquid Fuel
Textile Research Journal, 1972, p. 526-532

"A background in the chemistry of cellulose pyrolysis and hydrogenation is provided, and the cellulose liquefaction literature and state of the art is reviewed. A concept of an ultimate process in which cellulosic solid waste is used both to produce process hydrogen by the water-gas shift reaction and to provide the raw material for conversion to oil is developed. The theoretical yield of hydrocarbon oil from cellulose is 35.7 wt%, or 2.47 bbl/ton at 0.810 sp gr. An economic process will probably use a reaction medium of cellulosics slurried in oil and will require a catalyst that permits operations at pressures below 1000 psig. The heating value of refuse is approximately 5000 BTU/lb, on an as-is basis and 9000 BTU/lb on a moisture and ash-free (MAF) basis. At present, pyrolysis processes are capable of producing a tar (containing 20 wt % O_2) with a heating value of 12,000 BTU/lb and an equal yield of char. Hydrogenation processes have the potential of producing practically O_2-free oil approaching 18,000 BTU/lb, without the char by-product."

1972-1164
WESTING, T. W.; ALGEO, J. W.; ELAM, C. J.; and MARTINEZ, A.
Feedlot Particulate Matter Measurement (Abst)
Jnl. Animal Sci. 35: 195

"Particulate matter levels are 25 to 30 times greater in peak particulate matter hours in comparison to minimum particulate matter hours." Samples should be collected on a 24-hr basis.

1972-1165
WESTING, T. W.; ELAM, C. J.; ALGEO, J. W.; and MARTINEZ, A.
Control of Feedlot Particulate Matter (Abst)
Jnl. Animal Sci. 35: 196

Control of particulate matter in feedlots can be by watering (2.25 to 3.5 lit/m^2-day), by greater animal density, or by chemicals. "Optimum method of control was dependent primarily on feedlot design."

1972-1166
WHITE, Richard K. and EDWARDS, W. M.
Beef Barnlot Runoff and Stream Water Quality
Proc. Cornell Agr. Waste Mgmt. Conf. p. 225-235

The majority of beef cattle raised in Ohio are in barnlots where, by definition, 20 to 100 head have free access to lot or barn. Under these circumstances 1/4 to 1/3 of the total manure deposit is on the lot. The paper reports monitoring of runoff from such a barnlot where 60 cattle had access to 0.42 acres.

1972-1167
WILLETTS, Stephen
The Economics of Farm Waste Disposal
(Typewritten report) U. of Surrey
Abst: Agriculture 79: 232

This is a literature survey of the available papers through about 1970. Land disposal and sewage works type treatment are discussed. Cost data are given for British conditions. No separate bibliography is included.

1972-1168
WILLSON, G. B. and HUMMEL, J. W.
Aeration Rates for Rapid Composting of Dairy Manure
Proc. Cornell Agric. Waste Mgmt. Conf. p. 145-158

Aeration supplies oxygen for the microorganisms, it removes excess heat which they generate, and it removes moisture. A series of laboratory studies on benchtop and in half-ton bins is described.

1972-1169
WILMORE, Rex
Manure Deodorants. . . How Well Do They Work?
Farm Jnl. 96: June p. 22, 38

No deodorant is recommended as being effective and economical. In general, odor problems should be solved before they arise. In emergencies, however, some products may prove to be worth what they cost.

1972-1170
ZINDEL, Howard C.
DPW Recycling Facts Updated
Poultry Digest 31: 125-126

Studies at Michigan State University, including recycling 35 times with rations containing 12.5 percent and 25 percent DPW, have indicated that the practice is safe. No build-up of heavy metals has occurred. Operation costs will vary between $12 and $16 per dried ton without afterburners. With them, costs will about double. Properly processed and properly stored DPW "has a place in the list of ingredients for all animal rations."

Anonymous notes on page 127 tabulate layer performance on DPW and present the Food and Drug Administration position on recycling animal waste.

1972-1171
ZWERMAN, P. J.; KLAUSNER, S. D.; BOULDIN, D. R.; and ELLIS, D.
Surface Runoff Nutrient Losses from Various Land Disposal Systems for Dairy Manure
Proc. Cornell Agr. Waste Mgmt. Conf. p. 495-502

In test plots subjected to simulated rainfall, heavy mineral fertilization increased the runoff by fifty percent and increased the losses of soil, organic matter, total nitrogen, and total phosphorus. A six-ton application of dairy cattle manure cut these losses in half.

1972-1172
ANON
New Aerobic Process Turns Waste to Nutrients
Ag. Chem. 27: Dec-Jan. p. 24-27

Operation of an Ohio feedlot which digests 400 tons of cattle manure per day by means of a patented process is described. The manure, gathered from housed cattle, is packaged in bags for sale as an organic fertilizer.

1972-1173
ANON
Pyrolysis and Salvage Get Demonstration Tests
Amer. City 87: Nov. p. 44

Baltimore and San Diego County are to construct prototype plants to utilize pyrolysis. Baltimore will produce fuel gas then raise steam to be sold to a local utility. San Diego County will produce fuel oil from the wastes of Escondido and San Marcos. The fuel oil will be sold to local electric utilities. Salvage of ferrous metal and crushed glass will be a by-product of the operation.

1972-1174
ANON
Make a Profit on Manure
Amer. Farmer 47: Jan. p. 30

A feedlot in Fayetteville, North Carolina, which normally handles 8000 cattle buys extra manure from dairies which have concrete lots to meet its demand for dehydrated, bagged, sterilized manure. In processing, the manure is mixed with pine bark to absorb moisture. A seasonal market and odors are drawbacks.

1972-1175
ANON [Based on Myron D. PAINE]
Pollution Researchers Finding Many Answers, Expert Reports
Beef 8: Jan. p. 34

To maintain pond volume, provision should be made for settling solids before they reach the pond. Adequate feedlot drainage is the best odor preventive. Ponds should be emptied slowly, and irrigation should be by gravity with tailwater returning to the pond. Sprinkler irrigation tends to release odors to the air. A six-inch manure pack on lots is acceptable.

1972-1176
ANON [Based on Bob GEORGE]
The Price Tag to Stop Feedlot Run-Off
Beef 8: Apr. p. 6-7

For diversion terraces, settling basin, lagoon, and irrigation equipment adequate to meet conditions nine years in ten in Central Missouri, GEORGE tabulated costs. His minimum and maximum (gated-pipe system and big gun system for irrigating) were: For 200 head $1819 and 3339, for 400 head $2358 and 3878, for 800 head $3296 and 7571, and for 1200 head $4314 and 8710.

1972-1177
ANON [Based on Conrad GILBERTSON]
Engineer Sounds Warning on Use of Lagoon Waste on Field Crops
Beef 8: Apr. p. 15

Before irrigating with liquid from a lagoon, try it on a test plot. For reasons not completely understood, water from the same pond has been known to kill crops and to stimulate growth to three times that resulting from the same quantity of clear water.

1972-1178
ANON
Feedlot Pollution Control is Not an Expensive Item: Linder
Beef 8: Apr. p. 25

In this summary of the meeting of the National Livestock Feeders Association in Omaha, Bob LINDER described the drainage and storage facilities at an 1100-head Nebraska feedlot which cost the feedlot $293 and the ASCS $907. "Take care of your pollution problems and you eliminate many of your animal comfort problems -- and wind up with better gains."

Oxidation ditches were recommended for both hog and cattle operations. For cattle on confined feeding over an oxidation ditch in Iowa winters, Gerald FRANKL reported gains of 2.64 lb/day inside, 1.9 lb/day outside; feed consumptions of 8.9 lb per lb gain inside, 14.3 outside; and cost of gains $21.07 inside, $33.65 outside. The wheels should be well designed, and the installation should be as uncomplicated as possible.

J. Ronald MINER stressed that maintenance and good housekeeping are required with any disposal method and that the effluent was not fit to be discharged to a stream.

1972-1179
ANON [Based on Gerald FRANKL]
Iowa Beef Tests Show Profit for Feeding Ditch Effluent
Beef 8: Aug. p. 20-21

Use of Processed Animal Byproduct (PAB) cut feed cost per hundred pounds of gain by $1.22. "Cattle on the by-product material gained faster, ate more feed and had more efficient conversions than those on the standard control ration. The two rations were balanced to be nutritionally identical." Comparisons of 13 factors are tabulated.

1972-1180
ANON [Based on Harry MANGES]

Kansan Applies Feedlot Runoff to Corn Fields
Beef 9: Sept. p. 6

The safe upper limit of effluent from feedlots or of manure spread as fertilizer is still not known. Any application should take into account local quality, which may be highly variable. At Pratt, Kansas, four to eight inches of feedlot runoff appears to be optimum, but long-range effects must be watched closely. Fifty tons per acre of dry manure plus proper irrigation appears to be satisfactory. Sixty to ninety tons may be used every third year with none in the intervening years. Watch for groundwater pollution.

1972-1181
ANON [Based on R. L. VETTER]
Southern "Weed" May Improve Midwest Lagoons
Beef 9: Sept. p. 15

Studies at Iowa State University indicate that water hyacinths may remove 500 lb of nitrogen per acre and 18 percent of the phosphorus present. Five tons of dry matter per acre result from the 84 tons of plant material. Cattle will consume large amounts of fresh hyacinths, but processing costs are high.

1972-1182
ANON [Based on Sam EVANS]
Heavy Manure Application Helps Yields
Beef 9: Sept. p. 23

First year response to a heavy manure loading in Minnesota was good, but the long-term effects may be detrimental. Corn wilted in mid-summer of the second year on a heavily treated plot due to high salt concentration.

1972-1183
ANON [Based on James H. SLONEKER]
USDA Researcher Uses Manure to Make Feed and Wallboard
Beef 9: Oct. p. 5

By means of a two-stage process described at a Symposium of the American Chemical Society in New York, 43 percent of animal waste can be converted into a feed comparable with soybean meal. Another fifty percent is a fibrous material which can be treated with resin and pressed into a low-grade wallboard or, alternatively, may be used as a nutrient for fungus which, in turn, produce high-protein enzymes which make good chicken feed. A profit of $20 per ton is foreseen.

1972-1184
ANON
Waste Conversion Plant Opened In Arizona
Beef 9: Oct. p. 35

In a pilot plant at Casa Grande, Arizona, General Electric is treating the wastes from 100 cattle by means of thermophilic bacteria. Results of FDA tests are expected by mid-1973.

1972-1185
ANON
New Odor Control Product
CALF News 10: July p. 22

A product which has been subjected to limited testing is alleged to control odors and possibly reduce manure volumes. In lagoons it is claimed that it will take solids to the bottom and produce oxygen. It will also crack bottoms of lagoons, thus promoting seepage. "It was found that it would react with any dead organic matter, but it will not react with living matter. It has a pH of one, but you can wash you hands in it." Used on an 18-inch manure pack in a pen it reduced it to four inches. "There was no damage to the cattle." The product is manufactured by RAD Limited, Inc., of Yale, Oklahoma.

1972-1186
ANON
Feedlot Loses Odor Suit
CALF News 10: July p. 45

Producers, Inc., of McKinney, Texas, has been held liable for damages of $135 per acre to a neighbor's land due to odors from a feedlot. The Texas Supreme Court upheld the verdict of a district court in the case. No one lived on the land which was used only for farming and grazing. "The appeals court said the question was whether the value of the land was reduced for any purpose for which it might be sold."

1972-1187
ANON
Monfort Looks at Treated Manure for Tile and Plastic
CALF News 10: Aug. p. 4

Monfort, operator of feedyards producing a half million tons of manure per year, is planning intensive study of Dr. John McKENZIE's processes for pyrolysis of manure and glass above 300°C to produce tile, and, with introduction of varying amounts of air, to produce building bricks or insulation. Natural gas, crude oil, and water high in nitrogen are produced as by-products in about equal amounts (12-1/2 percent by weight of original partially-dried manure). Being a one-step process using low cost ingredients and producing a tile of superior quality, hopes are high.

1972-1188
ANON
GE Opens Recycling Plant
CALF News 10: Oct. p. 34, 80-81

GE opened a test facility at Casa Grande, Arizona, on 31 August to treat the wastes from 100 head of cattle by means of thermophilic bacteria to produce a pasteurized high-protein livestock feed supplement. Cattle manure consists largely of plant fiber constituents digested only slowly by usual strains of bacteria. Results are expected by mid-1973.

1972-1189
ANON [Based on John M. SWEETEN]
Manure Promoted for Cropland
CALF News 10: Dec. p. 18

Manure acts as a fertilizer; buffers alkaline soils; and improves porosity, granulation, water infiltration rate, and moisture retention. Residual effects may result in a profit even where handling costs exceed one-year value.

Salt accumulation should be checked. Maximum application rates recommended are 10-15 tons/acre depending on precipitation and irrigation practices.

Brief notes on the same page report increased hay yields on manure-fertilized land in California and warn of nitrate pollution in Nebraska.

1972-1190
ANON
Fresh Wastes Have More Nutrients
Egg Industry 5: May p. 54, 55

Tests by Cal J. FLEGAL, C. C. SHEPPARD, and D. A. DORN of Michigan State indicate that the longer the time lapse before drying poultry manure, the less the nutritive value of the manure. After 31 recyclings, DPW analyses were quite similar. Phosphorus rose from 2.4 to 2.8 percent and calcium fell from 10 to 7 percent for birds fed a 25 percent DPW diet. "Hen-housed production on the 12.5% diet was 62.4%, compared to 59.2% for the 25% diet and 59.6% for the controls."

1972-1191
ANON [Based on C. D. VAN HOUWELING]
FDA Needs Data on Feeding Manure
Egg Industry 5: Aug. p. 18

Current tests at Virginia Polytechnic Institute and at Michigan State University could induce the Food and Drug Administration to notify state feed control officials of an easing of the 1967 policy statement. "It is not likely that there would be blanket approval, for it would depend on the species involved, the type of litter or waste, and processing methods."

1972-1192
ANON
Technique Developed to Recycle Manure Into Cattle Feed
Environment News 2: Nov. p. 14

General Electric is producing 120 lb of feed daily from 340 lb of dry manure, the output of about 100 cattle, at Casa Grande, Arizona. Shreaded diluted manure moves through three fermentation tanks where it is consumed by thermophilic bacteria to produce a protein-rich end product which is odorless and tasteless.

Hamilton Standard Division of United Aircraft has a similar process, using bacteria already present in the manure, under laboratory study.

1972-1193
ANON
What Are You Doing About Your 1.57 Billion Ton Animal Waste Problem?
Farm Technol. 28 (3): 14, 16

Land spreading, with or without other processes, is the ultimate destination envisaged for solid and/or liquid manure. The trend is toward increased regulation of feedlots and other sources of manure.

1972-1194
ANON
Composting: One Solution to Feedlot Waste Disposal
Feedlot Mgmt. 14: May p. 32, 33, 36, 43
Abst: McO & B F-065

A method of continuous composting developed by Prof. K. L. SCHULZE of Michigan State University is described. "The end product, either in a ground or pelleted form, can be used as a feed supplement for ruminants, as an organic soil conditioner or as the basis for fertilizer. The cost is estimated to be $4 to $12 per ton. The "soil conditioner sells from $15 per ton in bulk to $42 per ton in bags."

1972-1195
ANON [Based on Jack C. TAYLOR]
The Door's Still Open to Refeeding Cattle Waste
Feedlot Mgmt. 14: May p. 60
Abst: McQ & B F-067

The Food and Drug Administration's policy statement of five years ago disapproving of the use of poultry litter for feed because of possible transmission of drugs, antibiotics and disease organisms still stands. "We must show FDA that cattle wastes can be processed for refeeding without harm to the animals or to the consumers who eat the meat and with nutritional benefit for the cattle."

1972-1196
ANON
This Plant Will Convert Waste into Protein
Feedlot Mgmt. 14: May p. 70-71
Abst: McQ & B F-068

The process used by General Electric at Casa Grande, Arizona, to produce high-protein feed supplement from cattle manure is diagrammed and explained.

1972-1197
ANON
Sagebrush for Odor Control: In the Feed or the Manure?
Feedlot Mgmt. 14: May p. 74
Abst: McQ & B F-069

Studies at Colorado State University indicate that chopped sagebrush in amounts of one or two lb/day has no effect on the cattle, but reduces manure odor. Salt in quantities of zero to four oz/day has no effect on gains.

1972-1198
ANON
Many Uses for Composted Manure
Feedlot Mgmt. 14: May p. 74a
Abst: McQ & B F-070

"Mechanized composting has arrived in the cattle feeding business as a means of reducing feedlot waste disposal problems." A machine built by General Motors is described and pictured. "There is a potential in the use of composted manure for recycling as feed for cattle and for bulk use on agricultural lands."

1972-1199
ANON [Based on Warren B. COE and Michael TURK]
Waste Conversion Unit Developed
Feedlot Mgmt. 14: Dec. p. 26

"The Hamilton Standard Division of United Aircraft Corporation has developed a process that converts manure into a livestock feed product and at the same time produces sufficient methane gas to supply the heat and electricity to run the process." The process, still in the laboratory testing stage, operates in the absence of oxygen using bacteria present in the waste to accomplish fermentation.

1972-1200
ANON
Warm Water Study
Feedlot Mgmt. 14: Dec. p. 61

Oregon State University is studying the possibility of routing warmed water from power plants through greenhouses raising cattle feed, breaking down animal wastes which could then feed algae, yeast or other single-celled proteins. These, in turn, would become cattle feed.

The water, then cool, would be reused.

1972-1201
ANON [Credited to Challenge, publ. by Gen. Elect. Space Division]
Arizona Feeds Helping in Beef Waste Reclamation
Feedstuffs 44: 6 Mar. p. 5

Arizona Feeds of Tucson is cooperating with General Electric in a project for the production of 120 lb per day of protein for cattle feed. The source is cattle manure.

1972-1202
ANON
General Electric to Recycle Beef Manure into Protein Feed at New Arizona Plant
Feedstuffs 44: 10 Apr. p. 4.

A pilot plant at Casa Grande, Arizona, scheduled to begin production in the summer of 1972 will process the wastes from 100 cattle by providing for digestion of the waste by thermophilic bacteria followed by harvesting of the bacteria for protein. Years of research have gone into the process wherein 400-500 lb manure (dry weight) will produce 120-150 lb protein. Other cellulose wastes would be amenable to the same process.

1972-1203
ANON [Based on J. V. MANNERING]
Swine Manure Land Application Rates
Hog Farm Mgmt. 9: Feb. p. 32-33

Land application of swine manure is recommended as a means of protecting surface and ground water from nitrogen and phosphorus excesses, of removing bacteria and pathogens through the "living filter" operation, of improving soil structure, and of least-cost disposal.

Nitrogen should not be returned to the land in excess of crop use. The amount of manure per acre to contain this amount of nitrogen depends on the animal ration, the ammonia conversion and denitrification before application, the crop type, and the climate. Typical values for swine wastes on various crops in Indiana are tabulated.

Salt buildup should also be considered.

1972-1204
ANON [Credited to UCF Market Bull. 19 Nov 71]
Is Dried Poultry Waste Good Feedstuff?
Poultry Digest 31: 33

Cornell investigators compared DPW to sawdust nutritionally, observing that chickens remove 85 percent of the nutrients from feed. Michigan State Universty reported on a feeding trial in which 12.5 percent of the corn was replaced by manure. After 31 passes the ration was "giving equal, if not better performance."

1972-1205
ANON [Credited to Clemson Univ. Poultry Letter, Oct. '71]
Should Superphosphate Be Used on Manure?
Poultry Digest 31: 42

Superphosphate has been used on manure accumulations below cages as a water absorbent for some years. After a four- to six-inch layer accumulates, natural drying renders the superphosphate relatively ineffective. Since superphosphate is frequently used as fertilizer, however, it becomes a question of the economics of adding it before or after field spreading.

1972-1206
ANON [Based on Donald D. BELL]
Why Poultry Manure Varies as Fertilizer
Poultry Digest 31: 90-91

Many farmers distrust poultry manure as a fertilizer because of uncertainty as to its content of nitrogen, phosphorus, and potassium. With "as is" samples in Riverside County, California, values ranged as follows: nitrogen: 0.5 percent - 6.0 percent by weight, phosphorus: 0.5 percent - 3.0 percent, potassium: 0.4 percent - 2.0 percent, and water: 7.8 percent - 69.5 percent. Major causes of the variation are moisture content, feed of poultry, and age of manure at time of drying or of delivery.

1972-1207
ANON [Based on Glenn O. BRESSLER]
Other Fertilizer Uses for Dried Manure
Poultry Digest 31: 136

Dried poultry manure in excess of market demands has proved useful in Pennsylvania on highway embankments, highly-acid strip mine lands, and other wastelands.

1972-1208
ANON [Based on Cal J. FLEGAL, C. C. SHEPPARD, and D. A. DORN]
Manure Storage Time Affects Value of DPW
Poultry Digest 31: 205

The protein percentage (dry basis) of dried poultry waste decreases from 30.3 for seven-day storage to 18.3 for 98-day storage of the manure before drying. Intermediate values are tabulated.

After 31 recyclings of DPW with collection and drying at intervals averaging 12 days, the crude protein at the end of the first cycle was 29.7 percent. For a ration percentage of 12.5 percent, the crude protein after the 31st cycle was 27.9 percent. Phosphorus content was 2.4 percent after the first, 2.8 percent after the 31st. Egg production was 62.4 percent on the 12.5 percent refeed, 59.6 percent on the control diet (zero refeed), and 59.2 percent on 25 percent refeed.

1972-1209
ANON
Molasses from Manure?
Poultry Digest 31: 208

"The Sulphur Institute reports that sulphur dioxide, an air pollutant from power and industrial plants, can be cooked with sludge, protecting the organic amino acids in the sludge from degradation, and enhancing the protein values." If sludge, why not poultry manure which has lost most of its nitrogen?

1972-1210
ANON [Based on C. D. VAN HOUWELING]
Data Needed on Safety of Recycling Waste
Poultry Digest 31: 294

The Food and Drug Administration is watching research results on the content of pathogens and residues harmful to animals and food in recycled litter. Until convinced of its safety, approval will continue to be withheld. Approval, if it comes, will be on a process-by-process basis as the safety of each process is established.

1972-1211
ANON [Based on Henry NUTTING]
How Nutting Pre-Dries Manure in Deep-Pit House
Poultry Digest 31: 385-386

Cones of manure build up on 1 x 4's some five inches apart suspended between cage and pit. The manure is air dried by an exhaust fan and pushed off into the pit semiannually. A four-year accumulation in the pit has a moisture content of 20 to 30 percent and a depth of 40 inches. It has little odor and attracts few flies.

1972-1212
ANON [Based on J. R. COUCH]
Processed Poultry Manure as a Feedstuff
Poultry Digest 31: 537

Poultry feces uncontaminated with litter may be fed to laying hens without detrimental effects on the health of the hens or on the taste of the eggs. DPW has a low energy content and is useful primarily for its phosphorus and amino acid content. It should not be fed to broilers and turkeys. Hens on DPW eat more (to get more energy) and produce more manure.

1972-1213
ANON [Based on Walter GOJMERAC. Credited to Wisc. Agriculturist,
    12 Aug 72]
Chickens Control Flies from Manure Stack
Poultry Digest 31: 546

"Chickens which eat fly maggots in dairy manure stacks at the University of Wisconsin's Electric Research Farm are doing a good job of fly control. . ." Two hundred fifty cockerels are housed in a yard to which the daily manure production is brought.

1972-1214
ANON [Based on Darrell TURNER]
Recycling of Wastes
Poultry Meat 23: March p. 8

The best way of disposing of excess nitrogen from poultry wastes is to recycle it through crops. Studies are under way on means of allowing nitrogen to return to the air or to be trapped on soil filters. In some circumstances soil filters have removed forty times the amount removable by crops.

1972-1215
ANON [Based on James H. SLONEKER]
Feedlot Waste Usable
Poultry Meat 23: Oct. p. 16

A two-step fractionation process for feedlot waste developed by the Agricultural Research Service, USDA obtains a fibrous residue, fifty percent of the waste, which can be pressed into board or used as a nutrient for fungus that produces a fiber-digesting enzyme. Chicken feed treated with the enzyme has improved digestibility. The fungus itself is almost half protein.

1972-1216
ANON [Based on Ronald JOHNSON]
Feeding Feedlot Waste
Prog. Farmer 87: Oct. p. 38

At Oklahoma State University 25 percent and 40 percent of the ration for sheep consisted of dry feedlot waste. "The wastes had extremely high ash contents, probably from dust and soil scraped up when the feed pens were cleaned." The tests are preliminary.

1972-1217
ANON [Based on W. Brady ANTHONY]
Feed of the Future?
Prog. Farmer 87: Dec. p. 30

"Wastelage" -- a product obtained by blending 48 percent corn, 12 percent hay, and 40 percent cattle manure (by weight) has proven to be a highly successful feed for cattle and sheep in tests at Auburn University over a number of years.

1972-1218
ANON [Based on James HALLIGAN and Robert M. SWEAZY]
More Manure Disposal
Prog. Farmer 87: Dec. p. 30

HALLIGAN and SWEAZY of Texas Tech are working on a project to obtain synthesis gas from feedlot manure. The gas would be used as a fuel or for conversion to ammonia to provide soil nitrogen. Use of ammonia increased from 150,000 tons in 1961 to 370,000 tons in 1971.

1972-1219
ANON
Disposing of Our Wastes -- Soil Can Filter, Crops Recycle Nutrients
Sunshine State Agr. Rsch. Rpt. 17: July-Aug. p. 8, 9, 12

Projects under investigation at the University of Florida include multistage lagoon treatment of the wastes from a 600-cow dairy followed by seepage irrigation, sprinkler irrigation, and compost disposal in phosphate-mined areas.

1972-1220
ANON
Planning Feedlot Waste Disposal
Wallaces Farmer 97: 22 Jan. p. 86

A farmer planning retaining and detention structures for pollution control may get technical assistance from the Soil Conservation Service (SCS) and financial assistance from the Rural Environmental Assistance Program (REAP).

1972-1221
ANON [Based on R. D. POWELL]
Manure Decreases Need for Fertilizer
Wallaces Farmer 97: 25 Mar. p. 6

Manure should be incorporated into the soil promptly to protect its fertilizer value from runoff and volatilization. The soil tilth values are difficult to evaluate, but are significant.

1972-1222
ANON
Test Ways to Reduce Feedlot Pollution
Wallaces Farmer v. 97 8 Apr. p. 50

On steep slopes, terraces and/or a series of basins can retain liquid wastes for pumping to cropland. Solid wastes may be allowed to settle and be removed for spreading when the basin is dry.

1972-1223
ANON
Removing the Smell from Manure
Water and Waste Trtmt. 15: Mar. p. A3

"Removing smells created by processing poultry manure has saved the world's largest operator in this field from closure." A British concern producing agricultural feed by drying the manure quickly at high temperature to preserve its protein value has added "after-burners" which heat the exhaust gases to 600°C before releasing them to a 75-ft stack. "The system has proved 100% effective."

1972-1224
ANON
Research and Technology
Water Resources Newsletter 7: Oct. p. 1 (Included in Water
Resources Bull. vol. 8 Oct.)

General Electric, in an installation at Casa Grande, Arizona, is using one-cell microbes to digest cattle manure. The resulting biomass, after being dried and powdered, is a tasteless, odorless, nutritious feed for chickens or cattle.

Hamilton Standard converts manure into livestock feed using bacteria already present. Enough methane is generated in the process to supply the heat and electricity needed for the operation.

1972-1225
ANON [WLJ]
Feeding Animal Wastes to Cattle Effective
Western Livestock Jnl. 51: Dec. p. 75

R. L. VETTER reports success with the feeding of PAWN (Processed Animal Waste Nutrients) as 37.25 percent of the ration. Liquid manure with five percent solids is obtained from an oxidation ditch 30 inches deep. Palatibility is no problem. Cattle should be eased onto PAWN gradually.

1972-1226
ANON
Environmental Protection Research Catalog
U. S. Environmental Protection Agency, Washington 2 v. 2342 p.

Volume 1 of this catalog contains descriptions of 5488 research projects classified under six major and a number of minor subject headings. Those pertaining to animal waste are in group 2 (water quality) and group 3 (solid waste management). Volume 2 contains indices by subject, investigator, performing organization, and sponsoring agency.

The 142 projects which appear to bear directly on the disposal and/or utilization of animal wastes are listed by investigator and title in Appendix B of this report.

1972-1227
ANON [President's Water Pollution Control Advisory Board]
The Relationship Between Animal Waste and Water Quality
EPA 16 p + appendices

The Board held meetings in Colorado 26-29 Oct 71 and in Illinois and Indiana 24-28 Jan 72 to hear testimony on the animal waste pollution problem. Field trips were combined with both meetings. The paper summarizes the hearings. As a consequence of the meetings, the Board presented ten recommendations to EPA. That on uses of animal wastes is:

"The Board believes that recycling animal wastes back onto the land is the best practical approach in most situations, particularly for smaller operators, through the use of catchment basins, lagooning systems, and/or solid waste handling techniques. There are also other possible uses which should be given full consideration. Testimony presented to the Board indicates that promising possibilities exist in converting animal wastes into fuels such as oil or gas, building materials, dry fertilizer, tires, etc., and in recycling back into animal feeds. [It is recommended] that the Environmental Protection Agency give high priority to funding for research and development projects which may develop practicable and safe alternate uses for animal wastes."

1972-1228
ANON
Agricultural Runoff: A Bibliography
WRSIC Pbln. 72-204 248 p.

This is a sub-collection of 158 abstracts from Selected Water Resources Abstracts, volume 1 through 4. A 76-page comprehensive index and a 13-page significant descriptor index enhance the usefulness of the volume.

1973-1001
ANTHONY, W. Brady; CUNNINGHAM, J. P., Jr.; and RENFROE, J. C.
Ensiling Characteristics of Mixtures of Various Feedstuffs and Animal Wastes (Abst)
Jnl. Animal Sci. 36: 208

Various products were tested for blending with manure from concentrate-fed cattle in various proportions for the preparation of a cattle ration. These included silages, green chopped forage, cottonseed hulls, peanut hulls, rice hulls, and almond hulls. Data on initial and final pH, concentrations in silage of dry matter, crude protein, ash, and lactic acids are listed. "Except for excess moisture ensiling characteristics were generally good. All hull mixtures were less satisfactory in chemical and physical properties than mixtures made with silages or green chopped rye forage."

In the oral presentation of the paper it was emphasized that the mixtures used must ferment rapidly to produce acids, preferably lactic, at a pH of about four, and that if the pH shifts rapidly toward neutrality in the feed trough, the product will have low nutritive value.

1973-1002
BARTH, C. L.; LYNN, H. P.; and NORTHERN, W. L.
Progress Report: Aerobic and Anaerobic Lagooning of Dairy and Milking Wastes
To appear as South Carolina Agr. Exp. Sta. Tech. Contrib. No. 1060

"Manure management in swine production has been simplified by the wide adoption and acceptance of the no-discharge anaerobic lagoon. . . They are dependable, low cost and successful." To evaluate the feasibility of the use of the no-discharge anaerobic lagoon for the treatment of all dairy production wastes in a warm climate, a series of laboratory testing, described in the paper, was undertaken. Highest percentage reductions of volatile solids for the dairy wastes were 51 percent at 24.3°C and 15 percent at 11.5°C.

1973-1003
BLAIR, Robert and KNIGHT, David W.
Recycling Animal Wastes. I. The Problems of Disposal and Regulatory Aspects of Recycled Manures
Feedstuffs 45: 5 Mar. p. 32, 34

"Since the dry-matter digestibility of manure is about 60% in the ruminant but only about 10-20% in the non-ruminant, it is reasonable to suggest that feeding manure to ruminant farm animals would make a very significant contribution to the manure disposal problem." In preparing manure for inclusion in rations reduce the moisture content to less than 15 percent. If storage is contemplated, the moisture should be less than 10 percent. The manure should be ground to reduce feathers and wood chips. Drug and feed additives should be evaluated and hygiene is important. Refeeding is permitted in England, but not in the Common Market Countries or the U. S. "Banning the use of manures as feedingstuffs on the grounds that they may contain certain feed additives may be considered over-cautious when these additives were allowed in feedingstuffs."

1973-1004
BRIDSON, Randy
Missouri Compares Costs of Two Waste Disposal Systems
Feedstuffs 45: 5 Mar. p. 16

In a paper presented by Myron BENNET, University of Missouri, at a Missouri Cattle Feeding Seminar, the cost for waste disposal per 100 lb of beef produced was stated to be 41 ¢ for an open lot system and 61 ¢ for a confinement system. Capital costs of a pit in the confinement system and labor costs for additional hauling as contrasted with lagoons pumped for irrigation annually led to the difference.

1973-1005
CARLSON, Franklin B.; YARDUMIAN, Louis H.; and ATWOOD, Mark T.
The TOSCOAL Process for Low Temperature Pyrolysis of Coal
Pres. at 165th Natl. Meeting of ACS, Dallas, Texas, April 9-13, 1973

"TOSCO is investigating the application of its oil shale retorting technology to coal processing in its 25-ton per day retorting pilot plant. Coal char with a high heating value, plus tar and gas, have been produced from high moisture content, low heating value subbituminous coal. The process, named "TOSCOAL," uses hot ceramic balls as a heat source. The process is described and the yields and properties of the products are presented."

1973-1006
CASWELL, L. F.; FONTENOT, J. P.; and WEBB, K. E., Jr.
Pasteurization of Broiler Litter and Utilization by Sheep (Abst)
Jnl. Animal Sci. 36: 196

Processes found to provide effective pasteurization were dry heat for 20 min at a depth of 0.63 cm, autoclaving for 10 min under a steam pressure of 1.05 kg/cm^2, dry heat followed by addition of 1 to 4 g of paraformaldehyde per 100 g of litter at depths of 0.63 cm and 2.54 cm, and ethylene oxide fumigation for 30 minutes or longer. "Method of processing litter had no significant effect on apparent digestibility and nitrogen utilization."

1973-1007
CLARK, R. N. and STEWART, B. A.
Amounts, Composition, and Management of Feedlot Runoff
USDA Southwestern Great Plains Research Center Tech. Rpt. No. 12
Symp. on Animal Waste Mgmt., Bushland, Texas. p. 32-42

Results of rainfall-runoff measurements on a feedlot at Bushland, Texas, are reported. For the storms monitored, runoff occurred with a half-inch or more of precipitation and was a linear function of the precipitation. "After a lot becomes wet, severe tromping creates many deep hoof depressions that can retain significant amounts of rainfall. Also, under a heavy stocking rate, the manure pack is thick and has a very high water-holding capacity."

"The use of playas for impounding feedlot runoff insures that runoff will not enter streams, rivers, or lakes. . . Very little percolation occurs through a playa. . . The potential of the feedlot to pollute the water table appears very slight when a playa is used as the catchment area."

Feedlot runoff, properly diluted with other runoff or well water, may be used for irrigation.

1973-1008
CREGER, C. R.; GARDNER, F. A.; and FARR, F. M.
Broiler Litter Silage for Fattening Beef Animals
Feedstuffs 45: 15 Jan. p. 25

Broiler litter on pine shavings was ensiled at 35-38 percent moisture content in an airtight silo for six weeks then fed with a 12 percent protein mix ad libitum to heifers for 120 days. The calves gained 2.54 lb per head per day. No drug carryover of any consequence occurred. Pathogens were eliminated by the heat of ensilage. A taste panel expressed some preference for steaks from control cattle but found the litter-fed beef highly acceptable.

1973-1009
CULLISON, A. E.; McCAMPBELL, H. C.; and WARREN, E. P.
Use of Dried Broiler Feces in Steer Rations (Abst)
Jnl. Animal Sci. 36: 218-219

In feeding tests in which 0, 50, and 100 percent of the supplemental protein (0, 5.8, and 13 percent of ration) came from dried broiler feces and the balance from soybean oil meal, daily gains were 1.20, 1.18, and 1.11 kg respectively; feed-to-gain ratios were 7.28, 7.53, and 7.90; dressing percentages were 59.6, 59.6, and 59.5; and carcass grades were 11.3, 11.3, and 11.2.

1973-1010
ELAM, M. L.
California Waste Ponds Are Passing the Test
Hoard's Dairyman 118: 10 Mar. p. 311, 362

Ponds in California's Central Valley have been found to be highly satisfactory for holding dairy wastes in that they have little odor, do not contaminate groundwater, and can be pumped for irrigation. For this latter purpose, blending with other waste is advised. Ponds should be large enough to hold all summer inflow. They should never be pumped dry since anaerobic bacteria are required to keep them effective.

1973-1011
GARNER, William and SMITH, Ivan C.
The Disposal of Cattle Feedlot Wastes by Pyrolysis
Environ. Protection Tech. Series EPA-R2-73-096 vii + 99 p.

Even after having postulated that "the criterion for optimization was the *yield* [italics supplied] of liquid organic compounds which were produced as water-soluble and water-insoluble oils and tars" rather than the *value* of the resultant products -- liquid, gas, and/or solid -- the report concluded that "economic pyrolysis might be feasible if the fresh manure were allowed to dry in an arid climate." This, however, would allegedly defeat "the whole premise of rapid manure disposal." Moreover, manure pyrolysates, like "coal tar, soot, and the fumes of broiling meat" are gratuitously suspected of being carcinogenic.

Laboratory procedures and a computer program for determining an optimal experimental design system are described. Appendix D, by Raymond C. LOEHR, presents a correlation of the composition of feedlot waste with the animal feed ration. Increased roughage would yield more and drier manure.

1973-1012
HARMON, B. W.; FONTENOT, J. P.; and WEBB, K. E., Jr.
Fermentation of Ensiled Broiler Litter and Corn Forage (Abst)
Jnl. Animal Sci. 36: 218

Analyses are tabulated for ensilages made with various proportions of broiler litter and with corn forage at two different states of maturity.

1973-1013
HERZOG, K. L.; PARKER, Harry W.; and HALLIGAN, James F.
Synthesis Gas from Manure
AIChE 75th Natl. Mtg. Paper 32c.

"With ammonia synthesis gas the objective, bench-scale studies of the partial combustion of cattle manure have been made. Results for continuous partial oxidation of -40 +60 sieve manure particles at feed rates up to 0.47 lb/hr in a 1.6-inch I.D. fluidized bed reactor are presented. The effect of increased reaction temperature, which was studied from 1285 to 1432°F, was to more than double ultimate H_2 yields from 8.5 to 18.5 SCF/lb dry, ash-free manure. These ultimate yields of hydrogen, which include projected conversions of the experimental yields of hydrocarbon gases, show that, given manure from 600,000 feedlot cattle, ammonia production of up to 920 tons/day can be achieved."

1973-1014
HILEMAN, L. H.
Sensible Use of Chicken Litter and Fertilizer on Pastures (Abst)
Jnl. of Dairy Sci. 56: 316

"Commercial fertilizers and chicken litter can supplement each other in a sound fertility program."

1973-1015
INGRAM, S. H.; ALBIN, Robert C.; JONES, C. D.; LENNON, A. Max;
TRIBBLE, Leland F.; PORTER, Lucy B.; and GASKINS, Charles T.
Swine Fecal Odor as Affected by Feed Additives (Abst)
Jnl. Animal Sci. 36: 207

Olfactory panels and quantitative determinations of organic amines and sulphides were employed in the evaluation of effects of additives on odors. "These data indicate that certain feed additives reduce the volatile matter of swine feces, but that changes observed were above the olfactory threshold of detection."

1973-1016
JAKOBSON, Kurt
Projects of the Agricultural and Marine Pollution Control Section
EPA Pbln. R2-73-171 201 + v p.

This document includes a compilation of the information sheets of the 160 projects initiated from the fiscal year 1968 through fiscal year 1972. The section on animal feedlots (p. 49-80) devotes one page to each of thirty projects. Title, author, performing organization, cost data, project officer, and a description of each project are included.

The completion reports of many of these projects are abstracted in this bibliography and/or cited in Appendix B.

1973-1017
JOHNSTON, Gene
Flushing: Near Labor Free Waste Handling
Hog Farm Mgmt. 10: Mar. p. 51, 54, 55

Ed MILLER, of Michigan State, has reported successful operation of a pivoted 200-gal water tank which remains upright until nearly full then dumps its contents into a flume under a slatted floor in seconds. Two or more flushes per day are adequate. The water flows to a holding pit or lagoon. Ultimate disposal is by irrigation. Recycling the water may introduce an odor problem.

1973-1018
KLETT, R. Hollis
Effect of Ration on Manure Salt Content
Symp. on Animal Waste Mgmt., Bushland, Texas. p. 26-31

Feeding tests have established that cattle on salt-free rations performed as well as those supplemented with 0.5 percent salt. The resulting manure posed less of a hazard when used as fertilizer.

1973-1019
LOEHR, Raymond C.; PRAKASAM, T. B. S.; SRINATH, E. G.; and JOO, Y. D.
Development and Demonstration of Nutrient Removal from Animal Wastes
EPA Pbln. R2-73-095 340 + xvii p.

"Laboratory and pilot plant studies evaluated processes applicable to the removal of nitrogen, phosphorus, and color from animal wastewaters. Three processes were evaluated: a) chemical precipitation of phosphorus, b)ammonia removal by aeration and c) nitrification followed by denitrification."

1973-1020
MASSIE, J. R., Jr. and PARKER, Harry W.
Continuous Solid Waste Retort -- Feasibility Study
AIChE, 74th Natl. Mtg Paper 43a 31 p. proc.

Continuous pyrolysis of cattle manure containing 30 percent moisture was demonstrated in a six-inch-diameter retort at a flow rate of 136 lb/hr-ft^2. By alternating injections of a gas containing oxygen and then free of oxygen, the heated portion of the retort was limited to the central portion well away from any mechanical parts. Operation is described. Further research holds high promise of demonstrating the feasibility of salvaging valuable products from manure while simultaneously removing all potential for pollution.

1973-1021
MATHERS, A. C.; STEWART, B. A.; THOMAS, J. D.; and BLAIR, B. J.
Effects of Cattle Feedlot Manure on Crop Yields and Soil Conditions
USDA Southwestern Great Plains Research Center Tech. Rpt. No. 11
Symp. on Animal Waste Mgmt., Bushland, Texas. p. 1-13

Tentative conclusions on the use of manure as fertilizer on the High Plains of Texas are that about ten tons per acre would appear to be optimum. Of the nutrients present in manure, only nitrogen is particularly valuable in High Plains soils. Excessive nitrogen leads to accumulations of ammonia in the soil and nitrate accumulation in forage plants. "When manure is applied to the soil surface, water management determines how much manure can be applied without decreasing yields."

"The soluble-salt content of manure is high and must be considered carefully when manure is used on cropland. . . Even moderate applications of manure may cause a high concentration of salts in the seeding zone."

1973-1022
McCROSS, John
The $85,000 Investment That's Paying Off
Beef 9: Jan. p. 50

Fink's 480-head feedlot near Ainsworth, Nebraska, with roof, indoor plumbing, natural air conditioning and computerized bookkeeping is paying off in more choice cattle, bigger crop yields from manure spreading, faster gains, and happier neighbors. A four-raceway oxidation ditch under the slotted floor provides irrigation and fertilizer on 66 acres of corn with intermediate storage of overflow in a pit. A tailwater recovery system protects against runoff of irrigation effluent.

1973-1023
MENEAR, J. R. and SMITH, L. W.
Dairy Cattle Manure Liquid: Solid Separation with a Screw Press
Jnl. Animal Sci. (In Press)

Dewatering processes are reviewed and performance of an experimental screw press of 15 cm diameter and 81 cm length in separation of dairy cattle manure into liquid and solid portions is described. The resulting solid is more convenient to handle and requires less energy for dehydration, if such be desired, than does the unseparated manure. The liquid portion is more suitable for treatment in oxidation ditch or lagoon, or for hydraulic transport than is the original product.

1973-1024
MORGAN, Neal O. and EBY, Harry J.
Animal Wastes Aeration Improves Bioreduction by Fly Larvae (Abst)
Agr. Engrg. 54: Feb. p. 26 [ASAE Paper 72-453] Abst: McQ & B G-182

Fly larvae can convert 100 lb of manure from poultry or cattle into 2.5 to 3 lb of good protein feed supplement (the larvae) and 50 to 60 lb of semi-dry, practically odorless soil conditioner. The manure must be stocked in climate-controlled chambers to avoid excessive moisture, which leads to anaerobic conditions and to possible death of the larvae, and to confine any flies which may hatch.

1973-1025
PARKER, Harry W.; ALBUS, Clarence J., Jr.; and SMITH, Gary L.
Costs for Large Scale Continuous Pyrolysis of Solid Wastes
AIChE, 74th Natl. Mtg. Paper 43b 25 p. proc.

Conceptual process designs which utilize the recently developed Texas Tech University retort to pyrolyze 2000 tons per day of either municipal solid waste or cattle feedlot waste are reported. The major product of these processes is the production of 30 megawatts of electricity.

A governmental entity which could finance the required 15 million dollar investment with six percent bonds over a 20-year period would have to charge users $1.40 per ton of municipal refuse processed or $0.50 per ton of feedlot waste pyrolyzed.

1973-1026
REDDELL, D. L.
Crop Yields from Land Receiving Large Manure Applications
Symp. on Animal Waste Mgmt., Bushland, Texas. p. 14-25

Manure was plowed into test plots at El Paso, Pecos, and Tulia, Texas, leaving several inches of manure-free soil above the manure. Seeds could thus germinate and the plant roots could grow into the manure to utilize the nutrients. Results are tabulated and discussed. "This work indicates that crops can be grown on land receiving up to 900 tons per acre of manure. Diminished yields may result the first year, but the yields will increase the second and third years after the manure application."

1973-1027
ROBINSON, J. B.; POS, Jack; EDWARDS, J. B.; and DUNN, G. G.
The Properties of Aerated, Stored, Liquid Poultry Manure with Special Reference to the Nitrogen Component
Fourth European Poultry Conf., London p. 513-522

Removal of nitrogen from poultry manure undergoing treatment in an overloaded oxidation ditch may be regulated to a considerable extent by the management of the ditch. "When maximum nitrogen retention is the objective, this may be most economically achieved using a variable speed mechanical aerator which can be adjusted as the load increases but operated at the speed necessary just to ensure minimum odour."

1973-1028
SANCHEZ, S. A.
Dung Beetles: Biological Weapon Against Horn Flies
The Cattleman, Mar. p. 76-77

A species of Afro-Asian dung beetle, *Onthophagus gazella*, introduced to South Texas from Australia, shows promise of helping control manure-breeding flies that affect cattle. Under optimum conditions, a cow dropping can be broken down in 24 hours through the cooperative efforts of about 50 conjugal pairs of beetles. *Onthophagus* appears to be able to survive winter weather and droughts. The beetle operates by working beneath the manure, breaking it down and burying it in underground tunnels. Being a night flier, it is less subject to such predators as cattle egrets, meadowlarks, toads, and wild turkeys. It is also less apt to become an intermediate host of parasites than are day crawling insects.

1973-1029
SENIOR, Frank C.
Evaluation of Economics Feed Recycle, Inc. Unit at Colorado River
Yard Showing Cash Flow, Costs and Break-Even Chart, and
Derivation of Rational Toll
Frank C. Senior, Consulting Engineer, Phoenix 9 p. proc.

For the process developed by SENIOR for the Feed Recycle, Inc., project at Blythe, California [1973-1043, and this report, p. 28]. costs for a 100 ton/day plant were calculated to be $33.04 per ton treated if operated at 25 tons/day, $19.22 if operated at 50, and $13.04 if operated at capacity. Values recovered per net ton of manure (based on 315 lb protein at 14 ¢/lb, 80 lb fats etc. at 9 ¢/lb, and 0.44 tons of roughage at $10 per ton) are $55.70 per ton. Costs of operation are itemized and a maximum cash outlay of $350,000 was found for operation at 85 percent capacity. It is contemplated that the plant will operate as a service unit processing manure which remains the property of the feedlot. At a toll of $35 per net dry ton it is calculated that the plant would show a pre-tax profit of $510,000 per year and that the yearly feed bill advantage to the participating feedyards would total $508,000. "Quite often feed yards feel that they are doing well at about $10 per year profit per animal fed. By splitting the advantage of recycle feed at $35 per ton, they can add $20 per animal or more than double their profit potential, remove pollution and allow a pretax ROI [recovery of investment] of about 10 months to one year for the Feed Recycle unit at 85% rating."

1973-1030
SHUYLER, Lynn R.
National Animal Feedlot Wastes Research Program
EPA Pbln. R2-73-157 33 + vii p.

The high-priority research needs in the animal feedlot program are seen as being:

"(1) The need to develop techniques for reprocessing and converting animal wastes into a usable product. Currently promising processes include conversion to some type of fuel, feed or feed additive for animals, or other by-product.

"(2) The urgent need to make the current information on animal waste management readily available for widespread use by governmental agencies, the feeding industry, and researchers in the field. . ."

The medium-priority needs consist of the control of ancillary pollutants and nuisances and the optimization of land spreading practices.

The 23 research projects which the program has sponsored are summarized.

1973-1031
SINKEVICH, Steven
Engineering for a Mushroom Farm
AIChE Paper No. 32a. Detroit, 6 June 8 p. proc.

Mushroom compost is based on horse manure. For the farm described (near Pittsburgh) the manure is supplied by local racetracks and (in winter) by shipment from New Orleans. A substitute compost can be made from chicken manure. The compost is used but once.

1973-1032
SMITH, L. W.
Nutritive Evaluations of Animal Manures
AVI Pbln. Co., Westport, Conn. [Publ. pending] 41 p. proc.

In general, monogastric manure has a higher feed nutrient content than ruminant manure. The nutrients in the manures from either monogastrics or ruminants are more effectively utilized by ruminants than by monogastrics. "Closed-continuous animal manure recycle systems do not appear feasible without intermediary processing of manure." The paper, destined to become a chapter of a book, surveys the literature on refeeding and includes 92 references.

1973-1033
SMITH, L. W.; CALVERT, C. C.; and MENEAR, J. R.
Dehydrated Poultry Manure as a Crude Protein Supplement for Sheep
Proc. Md. Nutrit. Conf. p. 35-44

Studies are reported in which digestibilities, intakes, and bodyweight gains are compared for wethers fed complete-pelleted diets supplemented with soybean oil meal (SBOM) or dehydrated broiler manure (DPM). Since poultry feed generally includes arsenicals, determinations were made of the amount of arsenic excreted by the sheep, and of the distribution and depletion rates of arsenic retained in various tissues after prolonged high-level arsenic feeding. Results, which are tabulated and plotted, include findings that "nitrogen from broiler manure supplemented diets was not significantly less digestible than SBOM nitrogen and was retained in the sheep equally well." While arsenic was detected in all tissues tested, "withdrawal of arsenic from feed results in a rapid decrease in tissue arsenic concentration."

1973-1034
SMITH, L. W. and FRIES, G. F.
Dehydrated Poultry Manure as a Crude Protein Supplement for Lactating Cows (Abst)
Amer. Dairy Sci. Assn., 68th Ann. Mtg., Pullman, Wash. 24-27 June.

A ration containing 32 percent dehydrated poultry manure (DPM) and a conventional control ration, both formulated to contain 17 percent crude protein were fed to lactating Holsteins. Cows on the DPM consumed less corn silage and less concentrate dry matter, gained less weight, and produced less milk. "In spite of reduced milk output, the economics of DPM feeding compare favorably to conventional CP." [Crude protein].

1973-1035
SWEETEN, John M.
Future Developments in Feedlot Waste Management
Symp. on Animal Waste Mgmt., Bushland, Texas. p. 43-50

In summarizing a symposium in which the major emphasis was on fertilizer values of beef feedlot manure, SWEETEN observed that state legislation in Texas provided for abatement of water pollution, and he discussed national legislation and anticipated EPA guidelines. Other recycling methods cited were the GE thermophilic bacteria studies, the Montford project for producing building materials from anaerobically-digested manure and waste glass, and various thermochemical processes. He advised caution in adopting any method other than "our present environmentally acceptable alternative -- land disposal." In regard to refeeding he wondered "if we can generally afford to collect manure as frequently as would be needed to preserve the feed value and whether cattle feeders can afford to utilize a feedstuff which, on a large scale, exhibits such wide variability in protein and ash content."

1973-1036
TAIGANIDES, E. Paul
Animal Waste Management -- Can We Learn from Europe?
Amer. Farmer 48: Feb. p. 19-20

Some European countries require an applicant for a permit to show adequate land for disposal. Screening, chemical treatment to settle solids, final filtration, and some treatments adequate to permit discharge of effluents to streams exist. Europe has been confronted with agriculture in an ecology-conscious urban environment.

1973-1037
VAN SLYKE, Steve
Making the Most of Manure
Amer. Farmer 48: Feb. p. 30-31

A Florida entrepreneur produces and sells 9000 tons per year of composted cow manure and potting soil produced in a virtually odor-free plant on the outskirts of Tampa.

1973-1038
WALDROUP, P. W.
Converting Hydrocarbons to Protein Sources for Poultry Feeding
Feedstuffs 45: 5 Mar. p. 34, 35

The subhead, "Rapid development and acceptance of single cell proteins may ease pressure on protein supplies and reduce industrial pollution," summarizes the paper. With proper precautions, yeast may constitute as high as 20 percent of the diet for young chicks. However, levels above 15 percent may result in sticky droppings and encrusted litter. On the whole, algae products have a low protein quality and poor taste acceptance. Since chicks have notoriously poor taste selection, they may be fed algae as a secondary protein source.

1973-1039
WEBB, K. E., Jr.; PHILLIPS, W. A.; LIBKE, K. G.; HARMON, B. W.;
and FONTENOT, J. P.
Different Levels of Broiler Litter in Ewe Rations (Abst)
Jnl. Animal Sci. 36: 218

Possible copper toxicity was the only problem encountered in a test in which ewes were fed a ration containing 0, 25, or 50 percent broiler litter pasteurized at 150°C for four hours. The tests extended through two lambing cycles. The first detrimental effects appeared after 16 months.

1973-1040
ANON [Based on Bob BLISS]
Feeders Scolded for Failing to Learn Their "Manure Economics"
Beef 9: Mar. p. 43, 66

In a USDA-sponsored symposium at Bushland, Texas, Bob BLISS stated that the disposal of liquid wastes and feedlot runoff in the High Plains was relatively simple. It can be caught in playa lakes and then pumped to the fields. Care should be exercised to capture tail-water for repumping. Solid wastes should be returned to the land. Research to determine optimum supplemental fertilizer programs, and salesmanship to encourage use by farmers were called for. A barter system in which the feedlot trades manure free of debris and with a moisture content under 40 percent for ensilage, grain, or hay was recommended.

1973-1041
ANON [Based on Myron BENNETT and Robert GEORGE]
How Much for Waste Disposal?
Beef 9: Mar. p. 44-45

Cost data are tabulated for a confinement building with slatted floors over a deep pit which is cleaned twice annually and for an open feedlot with lagoons. Both are located in Missouri. Manure from the pit is spread by honey wagon. Effluent from the lagoons is pumped for irrigation and the solids are removed and spread while the lagoons are dry. Costs are 60 ¢ to $1.40 per 100 lb gain for the confinement building and 40 ¢ to $1.40 per 100 lb gain for the open feedlot.

1973-1042
ANON [Based on John M. SWEETEN]
"The Smell of Money" Problem Must Be Dealt with Meaningfully
Beef 9: Mar. p. 66-67

Increased vigilance on air and water pollution will be required to prevent imposition of stricter regulation. Refeeding is possible. Beef manure contains from five to 25 percent crude protein and can be fed to cattle unprocessed or in a fermented state. Greater rates of gain and feed conversion efficiencies have been obtained by feeding fermented mixtures of fresh feedlot manure and roughage. "From a practical standpoint, however," SWEETEN is quoted as saying, "I wonder if we can generally afford to collect manure as frequently as would be needed to preserve the feed value and whether cattle feeders can afford to utilize a feedstuff which, on a large scale, exhibits such wide variability in protein and ash content."

1973-1043
ANON
Feed Recycling Showing Promise
CALF News v. 11, Jan. p. 28, 29, 52

The operation of the Feed Recycling Company of Blythe, California, in which manure is separated into fibrous material and a liquid containing protein, is described. "Each ton of manure from a conventional feedlot brings 400 pounds of protein. . . The fibers also have economic value as a feedback for the cattle, or for the manufacture of char or as a fuel." A unit capable of processing 100 tons of raw manure per day would have a capital cost of about $180,000 and an operating cost of not more than five dollars per ton. The resulting protein and fats should return $600,000 per year.

1973-1044
ANON [Based on James E. HALLIGAN and Robert M. SWEAZY]
Another Possible Process for Manure
CALF News v. 11, Jan. p. 38

Texas Tech professors James E. HALLIGAN and Robert M. SWEAZY are investigating the economic feasibility of obtaining synthesis gas from cattle manure, then using the synthesis gas to produce anhydrous ammonia for fertilizer. At present, methane gas is used for this process. While it is possible to produce methane gas from manure, several steps in the process can be eliminated by substituting synthesis gas.

The manure from 600,000 feedlot cattle would be sufficient to produce 1000 tons of ammonia per day.

1973-1045
ANON
Fuel & Feed from Manure
CALF News 11: Feb. p. 6, 68, 69

Hamilton-Standard's studies for the ARS on anaerobic digestion of manure are described. ". . . waste from 5,000 to 7,000 head of cattle would yield enough methane gas to provide heat and electric power to operate the process. The protein feed [produced in the process] would cost less than its estimated value."

"In the ARS contract studies, manure is slurried, heated and fed continuously to a fermentation tank. A mixture of microorganisms converts it to methane, carbon dioxide, and solid residue, which is dried as a feed ingredient." The residue may also be coated with resin and pressed into board or used as a nutrient for a fungus that produces a fiber-digesting enzyme which may be used to improve the digestibility of poultry feed.

1973-1046
ANON [Based on J. P. MARTIN]
Dangers of Manure Fertilization
CALF News 11: Feb. p. 46

Continuing soil analyses should be run to detect excessive amounts of sodium chloride, salt, potassium, and phosphorus. Requirements vary with climate and soil.

1973-1047
ANON
Animal Waste Management Symposium
CALF News 11: Mar. p. 18, 22

In papers at the Animal Waste Management Symposium at Bushland, Texas, Bob BLISS and A. L. BLACK each stressed the value of feedlot manure as a fertilizer. John SWEETEN cited a benefit-to-cost ratio of 3:1 for land disposal and suggested that other recycling methods were unlikely to attain such a value.

1973-1048
ANON
Another Recycling Venture
CALF News 11: Apr. p. 15-16

The Hamilton-Standard process employs anaerobic fermentation in the thermophilic temperature range to convert manure from beef cattle on a high-concentrate ration to methane and "biomass." The process is stable and reliable under variations in input quality, heat, etc. Advantages of the system include abilities to a) utilize very thick waste concentrations, b) operate with high process loading rates and small fermenter volumes, c) have low power requirements, and d) generate its own fuel energy. The process is able to double the crude protein contents of the manure and increase the amino acids by a factor of four. The dried biomass can replace soybean meal and cottonseed meal in the ration. Economic break-even appears to be in the vicinity of 5000 to 7000 head. Capital costs are 2/3, and operating costs 1/2 those of aerobic processes.

1973-1049
ANON [Based on Robert GEORGE]
Costs Noted for Solid and Liquid Waste System
Feedlot Mgmt. 15: Jan. p. 58

Cost figures for operations feeding 200, 400, 800, and 1200 head to comply with pollution laws in Missouri were calculated. For a lagoon and diversion terrace they ranged from $1139 (200 head) to $3034 (1200 head). For 200 head irrigation costs with gated pipe were $680, with handcarry pipe $1155, and with big gun $2200.

1973-1050
ANON [Based on Jacob BIELY. Credited to B. C. Animal and Poultry Sci. Seminar, May '72]
Chemical Evaluation of Dried Poultry Waste
Poultry Digest 32: 36

Of the total nitrogen in DPW about one-third is in uric acid, one-third appears as protein, and the other third is in peptides, urea, ammonia, nitrate, etc.

"The high content of ash limits the amount of DPW which can be used in chick and growing rations.

"The fat content is relatively low and compares to that present in cereal grains."

1973-1051
ANON
Enzyme from Feedlot Waste Used for Chicks
Poultry Digest 32: 77

A fiber-digesting enzyme produced from a fungus grown on cattle feedlot waste improved the feed efficiency of chicks in USDA feeding tests in Illinois. ". . . they ate less feed, produced less manure, but gained as much weight as chicks on two kinds of control feeds."

1973-1052
ANON [Based on James H. SLONEKER]

Manure Recycling Practical Process Seen
Poultry Meat 24: Feb. p. 8

USDA research has shown that -- contrary to earlier belief -- indigestible cellulose and hemicellulose does not build up in manure which is dried and re-fed as 25 percent of a chicken ration through 23 complete cycles.

1973-1053
ANON
Eau de Manure
To The Point 2: 21 Apr. p. 57

A Swiss chemist, Heinrich SPILLER, has announced the creation of a scintillating new perfume which "will send males literally climbing up the walls with passionate desire." Its basic ingredient is cow manure. Of all the manure SPILLER had tried cow manure was by far the best. "Truckloads are brought to his laboratory every morning."

APPENDIX B

DESCRIPTIONS OF RESEARCH PROJECTS IN THE DISPOSAL AND/OR UTILIZATION OF ANIMAL WASTES

Pertinent projects listed in the Environmental Protection Research Catalog [1972-1226] are listed in this appendix by serial number for reference in this report, researcher, researcher's affiliation, title, EP Research Catalog Number and page.

Nine projects (three of which duplicate listings in EP Research Catalog) listed in Active Research Projects Report, Fiscal Year 1972, National Environmental Research Center are also included. They show the same information except that the Catalog Number is that of the NERC catalog.

1972-B001.

ADAMS, W. E., U. S. Department of Agriculture

Soil Fertility Maintenance with Fertilizers, Crop Residues, and Animal Wastes.

Project 3.0368 Page 1-515

1972-B002.

ANDREWS, J. F., Clemson University

Thermophilic Aerobic Process for Waste Treatment.

Project 3.0308 Page 1-504

1972-B003.

APPLEMAN, R. D., University of Nebraska

Dairy Herd Management.

Project 3.0210 Page 1-485

1972-B004.

BARR, H. T., Louisiana State University

Lagoons for Disposal of Barn Yard Wastes.

Project 3.0152 Page 1-474

1972-B005.

BARTLETT, H. D., Pennsylvania State University

Feed and Waste Handling in the Dairy Operation.

Project 3.0295 Page 1-501

1972-B006.

BARTLETT, H. D., Pennsylvania State University

Subsurface Disposal of Animal Manure.

Project 3.0296 Page 1-502

1972-B007.

BARTLETT, H. D., Pennsylvania State University

Utilization of Agricultural Wastes in Crop Production.
Project 3.0294 Page 1-501

1972-B008.
BEER, C. E., Iowa State University
Using Soil Filtration to Reduce Pollution Potential of Lagoon Effluent Entering Ground Water System.
Project 2.1017 Page 1-299

1972-B009.
BESLEY, H. E., Rutgers the State University
Poultry Manure Disposal by Plow Furrow Cover.
Project 3.0217 Page 1-486

1972-B010.
BESLEY, H. E., Rutgers the State University
Volume Reduction and Stabilization of Wastes from Swine.
Project 3.0216 Page 1-486

1972-B011.
BLACKSTONE, J. H., Auburn University
Economics of Grade A Dairying.
Project 3.0057 Page 1-458

1972-B012.
BOND, T. E., U. S. Department of Agriculture
Evaluation of Meat Animal Housing Systems in Relation to Pollution.
Project 3.0209 Page 1-485

1972-B013.
BOND, T. E., U. S. Department of Agriculture
Livestock Environmental Facilities.
Project 3.0069 Page 1-460

1972-B014.
BOYD, J. S., Michigan State University
Farm Animal Waste Disposal.
Project 3.0181 Page 1-479

1972-B015.
BRESSLER, G. O., Pennsylvania State University
Agricultural Wastes - Poultry Manure Disposal and Use.
Project 3.0297 Page 1-502

1972-B016.
BRESSLER, G. O., Pennsylvania State University
Conversion of Poultry Manure to Useful Products.
Project 3.0399 Page 1-520

1972-B017.
BRODIE, H. L., University of Maryland
Pollution Loads in Percolate Water from Surface Spread Swine Wastes.
Project 2.1288 Page 1-343

1972-B018.
BRUGMAN, H. H., University of Maine
Feeding Broiler Litter to Dairy Replacement Heifers.
Project 3.0376 Page 1-517

1972-B019.
BRYANT, M. P., University of Illinois
Biological Methane Formation.
Project 3.0131 Page 1-470

1972-B020
BURNETT, W. E., State University of New York

Poultry Waste Disposal and Associated Odor Control.
Project 3.0232   Page 1-489

1972-B021.
BUTCHBAKER, A. F., Oklahoma State University
Cattle Feedlot Pen Design.
Project 3.0273   Page 1-497

1972-B022.
BUTCHBAKER, A. F., Oklahoma State University
Evaluation of Beef Feedlot Waste Management Alternatives.
Project 3.0272   Page 1-497

1972-B023.
CALVERT, C. C., U. S. Department of Agriculture
Biodegradation of Poultry Manure.
Project 3.0377   Page 1-517

1972-B024.
CLAYTON, J. T., University of Massachusetts
Closed Systems for Animal Sewage Treatment.
Project 3.0168   Page 1-478

1972-B025.
COLLINS, N. E., University of Delaware
Spray System for Daily Removal of Liquid Cow Manure.
Project 3.0099   Page 1-465

1972-B026.
CONVERSE, J., University of Wisconsin
Animal Waste Management with Pollution Control.
Project 3.0348   Page 1-511

1972-B027.
COTTIER, G. J., Auburn University
Broiler Management.
Project 3.0358 Page 1-513

1972-B028.
CROSS, O. E., University of Nebraska
Animal Waste Utilization for Pollution Abatement.
Project 2.1053 Page 1-305

1972-B029.
CROSS. O. E., University of Nebraska
Utilization of Livestock Waste to Abate Pollution.
Project 3.0008 Page 1-450

1972-B030.
DALE, A. C., Purdue University
Control of Flies and Other Insects Associated with Swine Production Without Insecticide.
Project 3.0140 Page 1-472

1972-B031.
DALE, A. C., Purdue University
Livestock Waste Treatment and Disposal.
Project 3.0141 Page 1-472

1972-B032.
DAVEY, C. B., University of North Carolina
Animal Waste Composting with Carbonaceous Material.
Project 3.0252 Page 1-493

1972-B033.
DAVIS, S. A., University of California

Soil and Water Management Systems for Disposal of Dairy and Poultry Wastes.

Project 3.0076 Page 1-461

1972-B034.

DAY. D. L., University of Illinois

Animal Waste Management with Pollution Control.

Project 3.0132 Page 1-470

1972-B035.

DIESCH, S. L., University of Minnesota

Survival of Pathogens in Animal Manure Disposal.

EP 00302 Page 614

1972-B036.

DONDERO, N. C., State University of New York

Waste Disposal.

Project 3.0233 Page 1-489

1972-B037.

DORNBUSH, J. N., South Dakota State University

Pollution Potential of Runoff from Livestock Feeding Operations.

Project 2.0361 Page 1-194

1972-B038.

DUGAN, P. R., Ohio State University

Concentration of Chemicals by Floc Forming Organisms.

Project 2.0933 Page 1-287

1972-B039.

DUNLAP, C. R., Louisiana State University

Single Cell Proteins from Cellulosic Wastes.

EP 00328 Page 688

1972-B040.
ENGLAND, D. C., Oregon State University
Management Practices Affecting Swine Production.
Project 3.0280 Page 1-498

1972-B041.
ESMAY, M. L., Michigan State University
Closed System Waste Management for Livestock.
Project 3.0182 Page 1-479

1972-B042.
EVANS, J. O., U. S. Department of the Interior
Ultimate Disposal of Sludges by Surface Spreading.
Project 3.0259 Page 1-494

1972-B043.
FLEGAL, C. J., Michigan State University
Farm Animal Waste Disposal.
Project 3.0184 Page 1-480

1972-B044.
FREED, V. H., Oregon State University
Chemical Transformation of Solid Wastes.
Project 3.0281 Page 1-499

1972-B045.
FREED, V. H., Oregon State University
Chemical Transformation of Solid Wastes.
Project 3.0282 Page 1-499

1972-B046.
GALLER, W. S., North Carolina State University

Animal Waste Composting with Carbonaceous Material.
EP 00270 Page 623

1972-B047.
GILBERTSON, C. B., University of Nebraska
Waste Management, Control, and Disposal in Midwest Beef Feedlots.
Project 3.0212 Page 1-485

1972-B048.
GOLUEKE, C. G., University of California
Comprehensive Studies of Solid Wastes Management.
Project 3.0066 Page 1-460

1972-B049.
GROSSMANN, E. D., Drexel University
Research on an Animal-Waste Pollution Control System.
Project 3.0289 Page 1-500
EP 00390 Page 612

1972-B050.
HAENLEIN, G. F., University of Delaware
Dairy Cattle Management in Urban Proximity.
Project 3.0364 Page 1-514

1972-B051.
HARTUNG, T. E., University of Nebraska
Decomposition and Dispersion of Excreta from Laying Hens and Turkeys.
Project 3.0009 Page 1-451

1972-B052.
HASHIMOTO, A. G., State University of New York
Handling and Disposal of Poultry Wastes.
Project 3.0234 Page 1-490

1972-B053.
HAZEN, T. E., Iowa State University
Farm Animal Waste Disposal.
Project 3.0143 Page 1-472

1972-B054
HERMANSON, R. E., Auburn University
Swine Waste Treatment and Disposal.
Project 3.0058 Page 1-458

1972-B055.
HILEMAN, L. H., University of Arkansas
Evaluation of the Nitrogen, Phosphorus and Potassium Content of Poultry Manure.
Project 3.0002 Page 1-449

1972-B056.
HINESLY, T. D., University of Illinois
Agricultural Benefits and Environmental Changes from Use of Organic Waste on Field Crops.
Project 3.0006 Page 1-450

1972-B057.
HOLTMAN, J. B., Michigan State University
Systems Applications in Agriculture.
Project 3.0185 Page 1-480

1972-B058.
HOWELLS, D. H., University of North Carolina
Role of Animal Wastes in Agricultural Land Runoff.
Project 2.0293 Page 1-182

1972-B059.
HUMENIK, F. J., University of North Carolina

Exploratory Study of Limitations of BOD for Animal Waste Evaluation.
Project 2.0712   Page 1-252

1972-B060.
HUMENIK, F. J., University of North Carolina
Treatment and Utilization of Wastes.
Project 3.0393   Page 1-520

1972-B061.
HUMMEL, J. W., University of Maryland
Animal Waste Composting Equipment for the Northeast.
Project 3.0164   Page 1-477

1972-B062.
INSKO, W. M., University of Kentucky
Production Efficiency in Cage Equipped Laying Houses as Influenced by Labor Practices.
Project 3.0150   Page 1-474

1972-B063.
JERIS, J. S., Manhattan College
The Biochemistry of Anaerobic Digestion.
Project 3.0228   Page 1-489

1972-B064.
JOHNSON, W. K., University of Minnesota
Nitrification and Denitrification of Waste Water.
Project 2.1312   Page 1-346

1972-B065.
Jordan, W. K., State University of New York
A New Practical Approach to Dairy Wastes.
Project 3.0392   Page 1-520

1972-B066.

KETTER, F. D., University of Pennsylvania

Pipe Transport of Solid Waste.

Project 3.0291 Page 1-501

1972-B067.

KLINGE, A. F., University of Maine

Disposal and Utilization of Dairy and Poultry Manures by Land Application.

Project 3.0156 Page 1-475

1972-B068.

KOLEGA, J. J., University of Connecticut

Disposal and Utilization of Dairy and Poultry Manures by Land Application.

Project 3.0097 Page 1-465

1972-B069.

LARSON. G. H., Kansas State University

Farm Animal Waste Disposal.

Project 3.0147 Page 1-473

1972-B070.

LARSON, G. H., Kansas State University

Farm Animal Waste Disposal.

Project 3.0148 Page 1-474

1972-B071.

LARSON, R. E., University of Minnesota

Evaluation of Waste Handling Systems for Housed Large Animals in the North Central Region.

Project 3.0196 Page 1-482

1972-B072.
LINDSAY, W. L., Colorado State University
Waste Composts as Chelating Agents in Plant Nutrition.
EP 00273 Page 628

1972-B073.
LIPPER, R. I., Kansas State University
Biological Treatment of Beef Animal Wastes to Reduce Water Pollution.
Project 2.1278 Page 1-341

1972-B074.
LOEHR, R. C., State University of New York
Tertiary Treatment of Animal Waste Waters.
Project 2.1346 Page 1-351

1972-B075.
LONGHOUSE, A. D., West Virginia University
Disposal and Utilization of Dairy and Poultry Manures by Land Application.
Project 3.0342 Page 1-510

1972-B076.
LUCKMAN, W. H., University of Illinois
Livestock Waste Management.
Project 3.0134 Page 1-471

1972-B077.
LUDINGTON, D. C., State University of New York
Disposal and Utilization of Dairy and Poultry Manures by Land Application.
Project 3.0237 Page 1-490

1972-B078.
LUDINGTON, D. C., State University of New York

Poultry Waste Handling System Design.
Project 3.0236 Page 1-490

1972-B079.
LUDINGTON, D. C., State University of New York
Systems for Alleviating Odors from Poultry Wastes.
Project 3.0235 Page 1-490

1972-B080.
MANGES, H. L., Kansas State University
Demonstration and Development of Facilities for the Treatment and Ultimate Disposal of Cattle Feedlot Wastes.
Project 3.0149 Page 1-474

1972-B081.
MAYES, H. F., University of Missouri
Improve Methods, Equipment & Facilities for Handling Waste Material from Livestock Markets & Feedlot.
Project 3.0203 Page 1-484

1972-B082.
McCALLA, T. M., University of Nebraska
Management of Cattle Feedlots and Animal Wastes for Control of Soil, Water and Air Pollution.
Project 3.0213 Page 1-486

1972-B083.
McCALLA, T. M., University of Nebraska
Soil and Water Management Systems for Prevention of Soil and Water Pollution.
Project 2.0240 Page 1-173

1972-B084.
McCALLA, T. M., University of Nebraska

Soil Productivity as Affected by Microbial Activity in Crop Residues and Animal Wastes.

Project 3.0389 Page 1-519

1972-B085.

McCALLA, T. M., University of Nebraska

Water and Soil Pollution from Beef Cattle Feedlots in Nebraska.

Project 2.0242 Page 1-173

1972-B086.

McCASKEY, T. A., Auburn University

Water Pollution by Dairy Farm Wastes as Related to Method of Waste Disposal.

Project 3.0059 Page 1-458

1972-B087.

McCASKEY, T. A., Auburn University

Water Pollution by Dairy Farm Wastes as Related to Method of Waste Disposal.

Project 3.0060 Page 1-459

1972-B088.

McKINNEY, R. E., University of Kansas

Cattle Feedlot Waste Water Treatment.

Project 2.1274 Page 1-340

1972-B089.

MERRITT, E., Meat Producers Incorporated

Soil Treatment of Cattle Feedlot Runoff.

Project 3.0322 Page 1-507

1972-B090.

MIDDAUGH, P. R., South Dakota State University

Bacteriological Water Quality Analyses of Methods for Detecting Fecal Pollution.
Project 2.0796 Page 1-266

1972-B091.
MIDDAUGH, P. R., South Dakota State University
Farm Animal Waste Disposal and Pollution Control.
Project 3.0312 Page 1-505

1972-B092.
MILLER, E. C., University of Minnesota
Animal Waste Management Study.
Project 3.0191 Page 1-481

1972-B093.
MILNE, C. M., Montana State University
Feed and Waste Removal Structures for Livestock.
Project 3.0208 Page 1-484

1972-B094.
MINER, J. R., Iowa State University
Abstract Service on Animal Waste Technical Literature.
Project 3.0007 Page 1-450

1972-B095.
MINER, J. R., Iowa State University
Demonstration of a Recirculating Swine Waste Treatment System Using a Rotating Biological Contractor.
Project 3.0144 Page 1-473
A Recirculating Waste System for Swine Units.
EP 00283 Page 611

1972-B096.
MINER, J. R., Iowa State University
Farm Animal Waste Disposal.
Project 3.0145 Page 1-473

1972-B097.
MOORE, C. R., Union Stockyards Company
Waste Treatment Facilities Demonstration.
Project 3.0258 Page 1-494

1972-B098.
MOORE, J. A., University of Minnesota
Farm Animal Waste Disposal.
Project 3.0197 Page 1-482

1972-B099.
MORRISON, S. M., Colorado State University
Cattle Feedlot Waste and Air and Water Pollution.
Project 3.0092 Page 1-464

1972-B100.
OLDHAM, W. K., University of British Columbia
Anaerobic Treatment of Animal Wastes.
Project 3.0085 Page 1-463

1972-B101.
OLDHAM, W. K., University of British Columbia
Anaerobic Treatment of Animal Wastes.
Project 3.0086 Page 1-463

1972-B102.
OSTRANDER, C. E., State University of New York

Poultry Waste Management and Odor Control.
Project 3.0239 Page 1-491

1972-B103.
OVERMAN, A. R., University of Florida
Land Disposal of Dairy Farm Waste.
Project 2.0994 Page 1-296

1972-B104.
PARKER, J. E., Oregon State University
Environment and Management of Laying Hens.
Project 3.0285 Page 1-500

1972-B105.
PARKER, M. B., Georgia Agricultural Experiment Station
Evaluation of Poultry Manure as a Fertilizer.
Project 3.0004 Page 1-449

1972-B106.
PEARSON, R. W., Auburn University
The Role of Soil in Farm Waste Management.
Project 3.0001 Page 1-449

1972-B107.
PFEFFER, J. T., University of Illinois
Reclamation of Energy from Organic Refuse.
Project 2.1261 Page 1-339
EP 00364 Page 684

1972-B108.
POMROY, J. H., University of Minnesota
Materials Handling Systems for North Central Farms.
Project 3.0198 Page 1-482

1972-B109.
PRATT, G. L., North Dakota State University
Farm Animal Waste Disposal.
Project 3.0256 Page 1-494

1972-B110.
PRATT, G. L., North Dakota State University
Livestock Waste Disposal System Involving Reuse of Water.
Project 3.0257 Page 1-494

1972-B111.
PRATT, P. F., University of California
Nitrate Pollution from Disposal of Dairy Waste.
Project 3.0077 Page 1-462

1972-B112.
REDDELL, D. L., Texas A & M University System
Water Quality Hydrology of Lands Receiving Farm Animal Wastes.
Project 2.0379 Page 1-197

1972-B113.
REED, C. H., Rutgers the State University
Handling and Disposal of Poultry Manure.
Project 3.0221 Page 1-487

1972-B114.
ROBERTS, J., Washington State University
Lagoons for Dairy Farms.
Project 3.0338 Page 1-509

1972-B115.
SCALF, M. R., U. S. Department of the Interior

Pollution Implications of Animal Waste.
Project 3.0011 Page 1-451

1972-B116.
SCHWARTZ, C. H., U. S. Department of the Interior
Vortex Incineration of Combustible Wastes.
Project 3.0292 Page 1-501

1972-B117.
SCHWIESOW, W. F., University of Maryland
Disposal of Waste from Swine Feeding Floors to Minimize or Eliminate Stream Pollution.
Project 2.1291 Page 1-343

1972-B118.
SCHWIESOW, W. F., University of Maryland
Disposal of Wastes from Swine Feeding Floors to Minimize Stream Pollution.
Project 2.1037 Page 1-303

1972-B119.
SCHWIESOW, W. F., University of Maryland
Disposal of Wastes from Swine Feeding Floors to Minimize Stream Pollution.
Project 3.0166 Page 1-477

1972-B120.
SEWELL, J. I., University of Tennessee
Farm Waste Disposal.
Project 3.0316 Page 1-506

1972-B121.
SEWELL, J. I., University of Tennessee

The Effects on Runoff, Groundwater, and Land of Irrigating with Cattle Manure Slurries.

Project 2.1418 Page 1-362

1972-B122.

SMITH, L. W., U. S. Department of Agriculture

Chemical and Physical Treatments of Cattle Excreta for Reducing Environmental Pollution.

Project 3.0161 Page 1-476

1972-B123.

SMITH, R. C., University of Delaware

Economic and Engineering Aspects of Water in Delaware's Agri-Business Industry.

Project 2.1213 Page 1-331

1972-B124.

SMITH, R. D., Combustion Power Company, Inc.

Subscale Experiments on the Model-400 Combustion Power Unit (CPU-400).

PH 86-68-198 Page 691

1972-B125.

SMITH, R. E., University of Georgia

Aerobic Disposal of Animal Wastes with Continuous Water Reuse.

Project 3.0111 Page 1-467

1972-B126.

SMITH, R. E., University of Georgia

Design and Operation Criteria for an Anaerobic Lagoon for Swine Waste.

Project 3.0113 Page 1-467

1972-B127.

SMITH, R. E., University of Georgia

Performance of the Inclined-Plane Trickling Filter for Aerobic Disposal of Animal Waste.

Project 3.0112 Page 1-467

1972-B128.

SOBEL, A. T., State University of New York

Poultry Manure Disposal and Associated Odor Control.

Project 3.0241 Page 1-491

1972-B129.

SOBEL, A. T., State University of New York

Poultry Manure Properties, Handling and Disposal.

Project 3.0240 Page 1-491

1972-B130.

STECKEL, J. E., Rutgers the State University

Disposal and Utilization of Dairy and Poultry Manures by Land Application.

Project 3.0223 Page 1-488

1972-B131.

STEPHENSON, M. E., Michigan State University

Thermophilic Metabolism in Solid Substrates.

Project 3.0188 Page 1-481

1972-B132.

STEWART, B. A., U. S. Department of Agriculture

Disposal of Animal Wastes by Agricultural Practices in the Southern Plains.

Project 3.0320 Page 1-507

1972-B133.

STUTZENBERGER, F. J., Weber State College

Solid Waste Cellulose Degradation by Thermactinomyces.

FP 00420 Page 625

1972-B134.

TAIGANIDES, E. P., Ohio State University

Automated System for Water Pollution Control from an Animal Production Unit.

Project 2.1378 Page 1-356

1972-B135.

TAIGANIDES, E. P., Ohio State University

Farm Animal Waste Disposal.

Project 3.0266 Page 1-496

1972-B136.

ULICH, W., Texas Tech University

Stabilization of Organic Wastes from Cattle Feedlots in Semi-Arid Climates by Composting Techniques.

Project 3.0012 Page 1-451

1972-B137.

VANREST, D. J., University of Puerto Rico

Design of Facilities for Animal Waste Disposal.

Project 3.0306 Page 1-504

1972-B138.

VIETS, F. G., U. S. Department of Agriculture

Management of Animal Wastes and Feedlots to Avoid Soil and Water Pollution.

Project 3.0093 Page 1-464

1972-B139.

WALKER, H. G., U. S. Department of Agriculture

Development of Processes for Improved Feeds from Agricultural Wastes.
Project 3.0361 Page 1-514

1972-B140.
WELLS, D. M., Texas Tech University
Characteristics of Waste from Southwestern Cattle Feedlots.
Project 3.0321 Page 1-507

1972-B141.
WILCOX, W., Illinois Packing Company
A Method of Manure Disposal for a Beef Packing Operation.
Project 3.0121 Page 1-469

1972-B142.
WILKINSON, S. R., U. S. Department of Agriculture
Poultry Manure Management on Farmlands in the Southeast.
Project 3.0005 Page 1-450

1972-B143.
WILLIAMS, R. B., University of Maine
Litterless High-Density Broiler Production System.
Project 3.0158 Page 1-476

1972-B144.
WILLSON, G. B., University of Maryland
Farm Animal Wastes Management.
Project 3.0167 Page 1-477

1972-B145.
WITZEL, S. A., University of Wisconsin
Winter Storage of Dairy Wastes in Northern Climates.
Project 3.0352 Page 1-512

1972-B146.
WOLFSON, D. E., U. S. Department of the Interior
Carbonization of Municipal and Industrial Waste.
Project 3.0039 Page 1-455.

1972-B147.
WOLFSON, D. E., U. S. Department of the Interior
Pyrolysis of Solid Wastes.
Project 3.0293 Page 1-501

1972-B148.
YOUNG, H. G., South Dakota State University
Analysis of Complete Livestock Production Systems.
Project 3.0313 Page 1-505

APPENDIX C

THE UNITED STATES DEPARTMENT OF AGRICULTURE'S CURRENT RESEARCH INFORMATION SYSTEM (USDA CRIS)

It should come as no surprize that the USDA and, in particular, its subdivision the Agricultural Research Service (ARS), has been in the forefront of research on the problems of the utilization and disposal of animal wastes. Through the kind cooperation of Robert G. YECK, National Program Staff, Agricultural Research Service, the compiler of this bibliography secured the pertinent CRIS reports of the USDA as of 13 Oct 1972. These are abstracted in this appendix.

A CRIS report is a summary of research, normally consisting of one to four typed pages, listing for each project the investigators, title, location, performing organization, agency identification, starting and terminal dates, and a serial number designation referred to as the accession number. Each report states the objectives of the investigation and the approach proposed. Progress reports, usually for annual periods with the latest placed first, follow. Publications which have resulted during each period are listed in the progress reports. It should be emphasized that the progress reports may be tentative in nature and must not be interpreted as definitive findings.

Several of the projects abstracted have been initiated too recently for a progress report to have been issued. They are, however, included as indicating valuable sources of information.

1972-C001
ADAMS, R. S., Jr.; FARNHAM, R. S.; and MARTIN, W. P.
Soil as a Biological Incinerator for Animal Manures and Solid Wastes
USDA CRIS Accession No. 0057044 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Minnesota

OBJECTIVES: To "examine the feasibility of utilizing a small area of soil as a solid waste disposal area." Drainage waters will be collected and analysed, and the lysimeter soil will be examined for accumulation and/or migration of clay, nitrates, phosphates, and organic matter.

1972-C002
ANDERSON, J. R.
Integrated Control of Flies and the Role of Dung-Inhabitating Insects in Natural Recycling of Dung
USDA CRIS Accession No. 0011709 4 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, California

OBJECTIVES: To determine the role of insects in the natural degradation and recycling of animal wastes and to determine the best management system to utilize the insect-degradable dung.

PROGRESS REPORT: Cattle droppings in four pasture settings were collected and the insects in them were studied. Natural enemies of flies were given particular attention. It was observed that "the use of wood shavings to promote more rapid drying of droppings and hence reduce fly breeding, does not accomplish the latter."

1972-C003
ANTHONY, W. Brady; MORA, E. C.; and McCASKEY, T. A.
Livestock Waste as Animal Feed
USDA CRIS Accession No. 0059951 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Alabama

OBJECTIVES: Determine chemical factors of manure-feed mixtures necessary for preservation in acceptable state for livestock consumption, and determine the feeding values of the manure-containing feeds.

PROGRESS REPORT: Lactic acid fermentation and survival of pathogens are under study. In ration testing, a mixture of 54 percent ground corn, 6 percent ground hay, 40 percent manure plus vitamin A and minerals produced 3.47 lb daily gain on 6.07 lb dry matter per lb gain.

A mixture of 48 percent ground corn, 12 percent ground hay, 40 percent manure plus vitamin A and minerals produced 3.70 lb per day on 5.97 lb dry matter per lb gain. A reference ration of 90 percent ground corn, 7 percent hay, and 3 percent supplement yielded 3.76 lb per day on 4.82 lb dry matter per lb gain.

1972-C004
AXTELL, C.
Integrated Control of the House Fly
USDA CRIS Accession No. 0014209 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, North Carolina

OBJECTIVES: To design an integrated program for the control of house fly breeding in poultry houses.

PROGRESS REPORT: Optimum fly control may be obtained by promoting a stable manure ecosystem, with more than one predator species, and using limited amounts of insecticides.

1972-C005
BARTON, T. L.
Poultry Waste Utilization
USDA CRIS Accession No. 0061700 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Arkansas

OBJECTIVES: To determine various methods of preparing poultry wastes for recycling through poultry in compliance with FDA and other regulatory agency requirements. Nutritive values and costs will be determined.

1972-C006
BEADICEK, D. F.; FOSS, J. E.; and CLARK, N. A.
Forest Buffer Strips in Controlling Animal Waste Runoff into Streams
USDA CRIS Accession No. 0061653 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Maryland

OBJECTIVES: To determine the effectiveness of several forest covers as buffer strips to minimize animal waste pollution. Runoff from spread dairy cattle manure will be analyzed.

1972-C007
BEARD, R. L.; HANKIN, L.; and SANDS, D.
Biological Disposal of Waste
USDA CRIS Accession No. 0060049 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Connecticut

OBJECTIVES: To convert poultry manure and other wastes to soil amendments or fertilizers through biological processing.

PROGRESS REPORT: "Factors governing degradability of poultry manure by flies are being evaluated." The conversion of flies fed on poultry manure to chicken food as insect protein is under study.

1972-C008
BOGGESS, W. R.; ARNOLD, L. E.; and BAKER, C. D.
Water Quality from Forested Watersheds in Southern Illinois
USDA CRIS Accession No. 0062011 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Illinois

OBJECTIVES: To determine the "filtering" effects of forest land on runoff from a cattle feedlot.

1972-C009
BOND, T. E.
Evaluation of Meat Animal Housing Systems in Relation to Pollution
USDA CRIS Accession No. 0021180 1 p.

SPONSORING ORGANIZATION: Livestock Engineering and Farm Structures Branch, Agr. Engrg., ARS, USDA

OBJECTIVES: To abate pollution through improved design of meat animal housing systems.

PROGRESS REPORT: A 3600-head beef feedlot was designed and occupied at Clay Center, Nebraska. Runoff is being caught and guided by a series of ditches. Twenty-one new buildings are being designed for beef cattle, swine, and sheep to further test waste control features.

1972-C010
BOYD, J. S.
Farm Animal Waste Disposal
USDA CRIS Accession No. 0027009 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Michigan

OBJECTIVES: To study drying of manure and performance of lagoons.

PROGRESS REPORT: Cost data for some dryers have been determined. Drying manure at 1000°F resulted in some loss of fertilizer value but produced a granular material which is easy to handle. Lagoon effluent has been utilized for irrigation without crop damage.

1972-C011
BRADFORD, R. R.
Effect of Animal Manure on Soil Properties, Nitrogen Transformations, Forage Yields and Quality
USDA CRIS Accession No. 0022136 1 p.

SPONSORING ORGANIZATION: ARS

OBJECTIVES: To determine the effects of applying manure at various rates up to 120 tons (dry basis) per acre on soil properties, nitrogen transformations, and forage production.

1972-C012
BRESSLER, G. O. and BERGMAN, E. L.
Conversion of Poultry Manure to Useful Products
USDA CRIS Accession No. 0055304 3 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Pennsylvania

OBJECTIVES: To perfect drying process for poultry manure and to determine optimum fertilizer application to strip mines and spoil banks.

PROGRESS REPORT: Two-stage drying has proved to be successful. Dehydrated poultry manure is a stable product which may be stored for extended periods without heating or odor. It has been effective as a fertilizer for establishing growth in strip mines and on spoil banks.

1972-C013
BRICIC, J. and HASHIMOTO, A. G.
Industrial Manufacturing Methods of Poultry Droppings on Large Farms
USDA CRIS Accession No. 0022836 1 p.

SPONSORING ORGANIZATION: University of Zagreb, Yugoslavia

OBJECTIVES: To develop equipment to pelletize poultry manure. The pelletized manure will be analyzed for nutrient content to reflect its use for recycling to the land or for refeeding.

1972-C014
BRUGMAN, H. H. and DICKEY, H. C.
Feeding Broiler Litter to Dairy Replacement Heifers
USDA CRIS Accession No. 0008603 3 p.

SPONSORING ORGANIZATION: Maine Agr. Ex. Sta.

OBJECTIVES: "To determine cost and feasibility of feeding broiler litter to replacement dairy heifers."

PROGRESS REPORT: Early phases of the program involved feeding broiler litter to sheep. Feeding efficiency was better on a twenty percent litter ration than on the control. Despite the presence of arsenic in the litter none was found in the carcass of slaughtered lambs.

1972-C015
BUTCHBAKER, A. F.; BADGER, D. D.; and WAGNER, D. G.
Animal Waste Management with Pollution Control
USDA CRIS Accession No. 0060004 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Oklahoma

OBJECTIVES: To make economic, biological, and physical analyses of waste management systems in the areas of collection, transport, treatment, and conditioning of wastes.

PROGRESS REPORT: A survey of feedlots in 18 states indicates that only one-fourth the costs are associated with waste handling; the other three-fourths are in the pen or building facilities. Study of beef manure treatment by means of an oxidation ditch continues. An anaerobic lagoon has been added to the system.

1972-C016
BUTCHBAKER, A. F.; MAHONEY, G.; and PAINE, M.
Cattle Feedlot Pen Design
USDA CRIS Accession No. 0004540 4 p.

SPONSORING ORGANIZATION: Oklahoma Ag. Ex. Sta.

OBJECTIVES: To determine the effectiveness of an oxidation ditch under a slotted floor beef cattle confinement shed.

PROGRESS REPORT: Oxidation ditch studies have been conducted to determine parameters for outside installations in the Southwest. "Alternative beef waste management systems were examined to determine minimum cost systems." Dynamic mathematical models have been developed.

1972-C017
CALVERT, C. C.
Biodegradation of Poultry Manure
USDA CRIS Accession No. 0021132 2 p.

SPONSORING ORGANIZATION: Poultry Research Branch, Animal Science Res. Div. ARS

OBJECTIVES: To study odor control, volume reduction, and useful products resulting from the catabolism of poultry manure by coprophagous insects (such as the house fly) and unicellular organisms.

PROGRESS REPORT: Poultry manure seeded with house fly eggs loses about 46 percent of its water content. It becomes odorless, loose, and crumbly. The pupae yield, about three to four percent of the fresh manure, has a protein content of 63 percent with a good amino acid profile. Emerging flies have a protein content of 75 percent. The catabolized manure did not support chick growth.

1972-C018
CHANG, A. C. and PRATT, P. F.
On-site Stabilization of Dairy and Beef Cattle Wastes
USDA CRIS Accession No. 0060042 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, California

OBJECTIVES: investigate the feasibility on on-site decomposition of animal wastes and simulate a management system mathematically.

PROGRESS REPORT: Manure accumulates in the vicinity of feed bunks and watering troughs. Downward movement of nitrates, chlorides, and organic carbon was slow.

1972-C019
CHESNIN, L.
Utilization and Disposal of Waste Products and Pollutants in Soil
USDA CRIS Accession No. 0060374 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Nebraska

OBJECTIVES: To evaluate the effects of animal, human, and industrial wastes and their decomposition products as fertilizers.

PROGRESS REPORT: Soil samples subjected to various loadings of organic wastes followed by corrective treatments of lime or gypsum are being analyzed. It appears "that salt contents of livestock rations should be held to minimum values to optimize the value of manure for disposal in soil."

1972-C020
CROPSEY, M. G. and WESWIG, P.
Douglas Fir Bark as a Filter Media for the Disposal of Animal Wastes
USDA CRIS Accession No. 0031900 2 p.

SPONSORING ORGANIZATION: Oregon Ag. Ex. Sta.

OBJECTIVES: To determine the effectiveness of Douglas fir bark as a trickling filter medium for treatment of poultry manure.

PROGRESS REPORT: Samples of water polluted with one, two, and four percent by weight of poultry manure were filtered through Douglas fir particles of various sizes with various bark-to-waste loading values. Larger size bark and heavier hydraulic and biologic loads gave higher rates of water cleaning.

1972-C021
CROSS, Otis E.
Allowable Pollutional Loads for Fish and Utilizing Animal Waste for Fish Production
USDA CRIS Accession No. 0057299 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Nebraska

OBJECTIVES: To determine the feasibility of utilizing livestock manure as a feed ration for bullheads and carp.

PROGRESS REPORT: Initial trials with 14 bullheads were discontinued after two fish died and the others failed to gain weight. A more intense lighting system has been installed in anticipation of resuming testing.

1972-C022
CROSS, Otis E.
Animal Waste Management with Pollution Control
USDA CRIS Accession No. 0057934 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Nebraska

OBJECTIVES: To determine the pollutional aspects of land spreading and incorporation of manure at various rates and depths with three different plant populations.

PROGRESS REPORT: "In experiments on loading manure on soil, no nitrates have been detected moving downward through the soil after plowing or after irrigation for two cropping seasons. Nitrate pick-up in irrigation tail-water is negligible."

1972-C023
CROSS, Otis E.; GILBERTSON, C. B.; and WOODS, W. R.
Management and Control of Beef Feedlot Waste
USDA CRIS Accession No. 0031826 3 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Nebraska

OBJECTIVES: To evaluate beef feedlot waste management practices.

PROGRESS REPORT: Rainfall-runoff correlations have been studied and tentative equations proposed. A "porous dam" may provide an effective means of causing settlement of solids. "Winter thaw runoff concentrations were about 10 times the rainfall-runoff concentrations." Quality of runoff is also being studied.

1972-C024
CROSS, Otis E.; MAZURAK, A. P.; and CHESNIN, L.
Utilization of Livestock Waste to Abate Pollution
USDA CRIS Accession No. 0055494 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Nebraska

OBJECTIVES: To evaluate the economic feasibility of manure applications on surface irrigated lands.

PROGRESS REPORT: During the first year under test, the transport of potassium restricted the runoff to reuse for irrigation only. No damage to potable groundwater occurred. Depth of plowing had no significant effect on yield.

1972-C025
CULLEY, D. D., Jr.
Utilization of Aquatic Plants for Waste Treatment and Animal Feeds
USDA CRIS Accession No. 0059059 1 p.

SPONSORING ORGANIZATION: Louisiana Agr. Ex. Sta.

OBJECTIVES: "To determine the feasibility of utilizing aquatic plants for treatment of agricultural and domestic waste by removing nitrogen compounds, phosphates, and various inorganic salts. To determine if plants grown on waste waters have sufficient nutritive value and can be produced in large enough quantities to warrant use as a feed supplement for poultry, swine, cattle, catfish, etc."

PROGRESS REPORT: "Spirodela oligorhiza [a duckweed] was grown on an animal waste lagoon, treated municipal sewage waters, and untreated septic tank water during the first three months of 1970. Protein content was 42, 31, and 30 percent respectively on a dry-weight basis. Water content of the plant averaged 95 percent. Improved growth rates occurred in poultry when this plant was substituted for alfalfa in chicken feed. . . Calculations revealed that about 1000 lbs of N, P, and K were removed from the lagoon per acre per year. "The amino acid content was well balanced."

1972-C026
DALE, A. C.
Animal Waste Management With Pollution Control
USDA CRIS Accession No. 0057430 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Indiana

OBJECTIVES: To relate odor control and decomposition of dairy cattle wastes to temperature, time, size of particles, and microorganisms present; and to investigate performance of deep aerated lagoons with irrigation systems in returning dairy cattle and swine wastes to the land.

PROGRESS REPORT: Irrigation from an aerated lagoon was an effective means of disposal of dairy cattle wastes. Studies of nitrogen removal by aeration indicate that one-half the total nitrogen in dairy cattle manure may be lost in the form of ammonia, and one-third may be converted to nitrates and nitrites. The harvesting of microbial protein from cow manure may yield a product deficient in only one essential amino acid, methionine, which may be refed as 18 percent of the diet and as one-half of the supplemental protein.

1972-C027
DAVIS, H. R. and SPRAGUE, D. C.
Environmental Conditions for Layers in Cages and Management of Manure in a Deep Pit
USDA CRIS Accession No. 0059733 1 p.

SPONSORING ORGANIZATION: New York Agr. Ex. Sta.

OBJECTIVES: To study the storage and treatment of poultry manure under various fan usages in a pit.

PROGRESS REPORT: In addition to standard ventilation on the first floor of a poultry house, six fans circulated air over the droppings. "The 800,000 lbs of water removal from the droppings by drying equalled the combined dry matter and water removal at cleaning time. There was a significant reduction in odors as the material was spread on the land."

1972-C028
DAY, Donald L.
Animal Waste Management with Pollution Control
USDA CRIS Accession No. 0001888 3 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Illinois

OBJECTIVES: To obtain design data for oxidation ditches and to evaluate the feeding potential of oxidation ditch mixed liquor.

PROGRESS REPORT: Design criteria have been established for oxidation ditches and several prototypes have been constructed and placed in operation. "It appears that aeration systems can be designed to give various degrees of odor control."

Swine oxidation ditch mixed liquor (ODML) samples were passed through a series of sieves. It was found that the ODML passing the 200 mesh screen contained 83 percent (dry basis) crude protein, undoubtedly largely bacterial cells. This fraction contained 3.8 percent lysine. By utilizing the protein-rich fraction for refeeding in the building where it is produced, processing costs are minimal and the need for additional waste disposal facilities is reduced.

1972-C029
DOBSON, J. W., Jr.
Evaluation of Poultry Manure as a Fertilizer
USDA CRIS Accession No. 0003479 3 p.

SPONSORING ORGANIZATION: Georgia Ag. Ex. Sta.

OBJECTIVES: To evaluate poultry manure as a fertilizer for corn, forage, and horticultural crops and to determine the fertilizer nutrients needed to balance poultry manure.

PROGRESS REPORT: In North Georgia poultry manure has proved to be an excellent fertilizer for corn, cool season grasses, and bermudagrass. On fescuegrass pastures it has caused grass tetany and related problems which have led to the losses of large numbers of cattle. Possible amendments to correct for this are under investigation.

1972-C030
DONDERO, N. C.
Waste Disposal
USDA CRIS Accession No. 0024458 3 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, New York

OBJECTIVES: To determine the relation of animal wastes to receiving waters and air.

PROGRESS REPORT: Chemical and biological analyses of the effluent from a cattle feedlot and of the air from a poultry unit with an interior oxidation unit are being made on samples gathered over several seasonal cycles.

1972-C031
DURFEE, W. K.; McKIEL, C. G.; and WAKEFIELD, R. C.
Poultry Manure Management by Solids Separation, Effluent Treatment, and Recycling
USDA CRIS Accession No. 0059914 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Rhode Island

OBJECTIVES: To develop and evaluate a poultry manure management system which will reduce flushing water, renew effluent by soil and sod filtration, and use the sludge produced.

PROGRESS REPORT: The test facility has been completed.

1972-C032
FLEGAL, Cal J.
Farm Animal Waste Disposal
USDA CRIS Accession No. 0001567 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Michigan

OBJECTIVES: A) Study poultry performance on recycling of manure, and B) study electro-osmosis applications to manure drying.

PROGRESS REPORT: Dehydrated poultry waste in the diet of laying hens reduced egg shell thickness when fed as 10, 20, or 40 percent of the ration. It lowered egg production at 40 percent. Performance on recycling was as good with 10 or 20 percent DPW refed as with no DPW. Performance was poorer at 30 percent. Tests on hen excreta yielded 1.73 percent protein N, 2.14 percent non-protein N, 7.78 percent Ca, and 2.56 percent P.

1972-C033
GENETELLI, E. J.
Animal Wastes
USDA CRIS Accession No. 0060382 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, New Jersey

OBJECTIVES: To "develop an aerobic fermentation process in which the organic matter in manure is metabolized and assimilated as the nutrient media for the growth of microorganisms."

1972-C034
GERRISH, J. B.
Animal Waste Management with Pollution Control
USDA CRIS Accession No. 0057926 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Michigan

OBJECTIVES: To optimize anaerobic-aerobic treatment of diluted screened wastes.

PROGRESS REPORT: "Swine wastes and beef cattle wastes respond well to screening; the solids can be efficiently dried, the liquid fraction exhibits enhanced biodegradation. Thus the screen appears to be a feasible proposition both for new installations and as an 'add on' to an already heavily loaded or overloaded lagoon." Studies are being conducted to optimize the retention time of the anaerobic phase of the sequential anaerobic-aerobic lagoons.

1972-C035
GERRY, R. W.
Biological Studies with Chickens
USDA CRIS Accession No. 0008606 4 p.

SPONSORING ORGANIZATION: Maine Agr. Ex. Sta.

OBJECTIVES: To determine the nutritional value of various feed components and the effect of management practices on poultry performance.

PROGRESS REPORT: A portion of the program consisted of substituting litter protein for 0, 25, and 50 percent of the soy protein in the ration for layers. "Treatments had little effect on feed consumption or egg weight but as the 'litter' was increased in the ration, bird weight loss increased and percentage egg production decreased."

1972-C036
GIDDENS, J. E.
Fertilizers and Organic Wastes Applied to Soils in Relation to Environmental Quality
USDA CRIS Accession No. 0060417 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Georgia

OBJECTIVES: To determine the effect of land application of poultry manure on plant growth and on quality of runoff.

PROGRESS REPORT: Coliform bacteria were not found in any soil samples. Pond water receiving runoff from areas of high application of poultry litter is high in coliform bacteria except in periods of low rainfall.

1972-C037
GILBERTSON, C. B.
Waste Management. Control, and Disposal in Midwest Beef Feedlots
USDA CRIS Accession No. 0019796 3 p.

SPONSORING ORGANIZATION: Livestock Engineering and Farm Structures Branch, Agricultural Engineering, ARS, USDA

OBJECTIVES: To develop beef feedlot criteria for design for economical waste management and disposal with effective pollution control. Emphasis is on systems of waste disposal that can be adapted to existing feedlots to prevent water contamination by the runoff.

PROGRESS REPORT: Measurements of rainfall, snowmelt, and runoff were made and correlations of various parameters of runoff quality with precipitation, animal density, lot slope, etc., were studied. Tentative results are reported. "Winter thaw concentrations were about 10 times the rainfall-runoff concentrations."

1972-C038
GILBERTSON, C. B. and SCHAPLER, F. L.
Pierced Steel Plank as a Surface for Beef Cattle Feedlots
USDA CRIS Accession No. 0021846 1 p.

PERFORMING ORGANIZATION: Agricultural Improvement Corp., Mitchell, South Dakota

OBJECTIVES: "To investigate the feasibility of using peirced steel planking as a feedlot surface for alleviation of water pollution.'

PROGRESS REPORT: Eight test feedlots -- two untreated, two with pierced steel planking on soil, two with a gravel sub-base, and two with gravel sub-base plus collecting pipes -- are being built. The pens with gravel sub-base will have the soil beneath the gravel sealed to prevent infiltration. All lots will drain to lagoons.

1972-C039
GILMOUR, C. M.; BECK, S. M.; and MULLINS, A. M.
Land Disposal of Cattle Feedlot Wastes
USDA CRIS Accession No. 0060522 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Idaho

OBJECTIVES: To evaluate the fertility status of soil upon addition of cattle waste.

PROGRESS REPORT: "The primary focus will be placed on rates of decomposition of feedlot solid waste in soil as observed by transformations of carbon and nitrogen and as noted by related changes in soil nutrient status." Instrumentation has been developed.

1972-C040
GREATHOUSE, T. R.
Effect of Wintering and Pasturing Cattle Along Rivers and Streams
on Water Quality and Bank Erosion
USDA CRIS Accession No. 0060280 1 p.

SPONSORING ORGANIZATION: Michigan Agr. Ex. Sta.

OBJECTIVES: To "evaluate the effect of wintering and pasturing cattle along rivers and streams on water quality and bank erosion."

PROGRESS REPORT: During the first year of the proposed five-year study a lake was lowered by being diverted into the stream on which measurements were taken. "Due to stream flooding, no differences were observed in nutrient concentrations of the various samples."

1972-C041
HAGHIRI, F.
Land Disposal of Animal Waste
USDA CRIS Accession No. 0060752 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Ohio

OBJECTIVES: To "determine the maximum rates of beef cattle manure than can be applied to various soil types of Ohio without soil and water pollution."

1972-C042
HANSEN, R. W.
Cattle Feedlot Waste and Air and Water Pollution
USDA CRIS Accession No. 0010459 4 p.

SPONSORING ORGANIZATION: Colorado Ag. Ex. Sta.

OBJECTIVES: To determine means of feedlot design and operation for minimization of environmental contamination.

PROGRESS REPORT: Samples of groundwater at feedlots were analyzed for nitrate, ammonia and phosphate. The hydrology of feedlot runoff and the factors controlling it are being studied.

1973-C043
HARMON, B. G. and JENSEN, A. H.
Nutritional Value of Oxidation Ditch Residue (Swine Excreta) for Swine and Rats
USDA CRIS Accession No. 0056993 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Illinois

OBJECTIVES: To measure the nutrient composition of oxidation ditch residue and evaluate procedures for enhancing its value.

PROGRESS REPORT: Concentrations significantly higher than the two percent dry matter typical of ODR will be required. For an oxidation ditch in continuous operation three years the dry matter tested 51 percent protein, 1.4 percent lysine, 2.0 percent threonine, 0.9 percent methionine, and 40 percent ash. Mineral buildup may limit the period of continuous operation.

1972-C044
HASHIMOTO, A. G.
Handling and Disposal of Poultry Wastes
USDA CRIS Accession No. 0019900 2 p.

SPONSORING ORGANIZATION: Livestock Engineering and Farm Structures Branch, Agr. Engrg., ARS, USDA

OBJECTIVES: To develop equipment and procedures to reduce the pollution hazards from poultry wastes.

PROGRESS REPORT: "Aeration lowers the odor and nitrogen levels in chicken manure slurries." A two-stage process involving conversion to ammonia followed by ammonia stripping is particularly effective. A formula has been developed for determining the concentration of ammonia nitrogen as a function of time and other parameters.

1972-C045
HERMANSON, R. E. and PEARSON, R. W.
The Role of Soil in Disposal of Cattle Manure in Warm, Temperate Climate
USDA CRIS Accession No. 0057357 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Alabama

OBJECTIVES: To "determine whether cattle manure can be disposed of on the land at high rates without long-term damage to soil productivity or water pollution."

PROGRESS REPORT: Plots treated with 20 tons (dry matter) of manure per acre had runoff with higher COD than the test plots. Otherwise, the quality was essentially the same. "The treated plots produced slightly more millet and rye than did the checks."

1972-C046
HERRICK, R. B.
Metabolism and Deposition of Insecticides in Fowl
USDA CRIS Accession No. 0003197 3 p.

SPONSORING ORGANIZATION: Hawaii Agr. Ex. Sta.

OBJECTIVES: To Determine the effects on poultry, eggs, and several species of fly larvae of including various larvicides in poultry rations.

PROGRESS REPORT: Results varied from no effect to death for various insecticides fed quail, leghorn cockerels, and laying hens. Several publications resulted from the study; these should be consulted for details.

1972-C047
HILEMAN, L. H.
Effect of Animal and Other Organic Wastes on Soil Properties and Pollution Abatement
USDA CRIS Accession No. 0003202 3 p.

SPONSORING ORGANIZATION: Ark. Ag. Ex. Sta.

OBJECTIVES: To continue chemical analyses of poultry and animal manures, to study the ability of soil types to accept various wastes, and to investigate new methods of land disposal.

PROGRESS REPORT: Compost made from broiler manure-litter applied at rates of six and twelve tons/acre was effective in reclaiming soil polluted with oil field brines. Application of broiler litter to corn or fescue in excess of four tons/acre increased the nitrate content to toxic levels and decreased the magnesium to deficiency levels for livestock consumption.

1972-C048
HOWELL, E. S.
Litter Management in a Heated Concrete Floor Broiler House
USDA CRIS Accession No. 0055121 2 p.

SPONSORING ORGANIZATION: Georgia Ag. Ex. Sta.

OBJECTIVES: To determine litter requirements and possible further utilization of used litter from heated concrete floor broiler houses.

PROGRESS REPORT: Chicks did well with no litter. "Waste was dried from 30% moisture to 10% moisture in 48 hrs."

1972-C049
HUMENIK, F. J. and HOLMES, R. G.
Treatment and Utilization of Wastes
USDA CRIS Accession No. 0056182 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, North Carolina

OBJECTIVES: To investigate biological methods for removal and conservation of nutrients from wastes.

PROGRESS REPORT: Loading rates permissible for irrigating with swine or dairy animal wastes which have received various treatment are being determined. The fate of additive copper fed to swine is being investigated. "Work continues to document the unsuitability of the BOD test for animal waste evaluation."

1972-C050
KLINGE, A. F. and EPSTEIN, E.
Disposal and Utilization of Dairy and Poultry Manures by Land Application
USDA CRIS Accession No. 0030759 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Maine

OBJECTIVES: To "develop and evaluate disposal and utilization systems for land application of treated and untreated dairy and poultry manure that will minimize the pollution of water, soil, and air."

PROGRESS REPORT: Dried poultry manure (12 percent moisture) was applied to test plots at 0, 7, and 28 tons per acre. Wet manure was applied at 75 tons per acre (65 percent moisture). Runoff characteristics under simulated rainfall are reported.

1972-C051
KLOSTERMAN, E. W. and McCLURE, K. E.
Utilization of Waste Materials as Feed for Ruminants
USDA CRIS Accession No. 0058888 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Ohio

OBJECTIVES: To determine the chemical composition, palatability, digestibility, and feeding value of feedlot manure and other wastes.

PROGRESS REPORT: Ensiled feedlot manure, fed as the sole ration to steers for 60 days, was adequate for maintaining weight. The addition of hydrolyzed animal-vegetable fat (at an eight percent of dry matter level) tended to depress intake and digestibility of fermented manure.

1972-C052
KOLEGA, J. J. and WENGEL, W. R.
Disposal and Utilization of Dairy and Poultry Manures by Land Application
USDA CRIS Accession No. 0030283 3 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Connecticut

OBJECTIVES: To "develop and evaluate disposal and utilization systems for land application of treated and untreated dairy and poultry manure that will minimize pollution of water, soil, and air."

PROGRESS REPORT: Applications at the rate of 60 and 120 tons/acre (dry basis) have been made to four field lysimeters over four years. Corn yield was depressed for poultry manure at 120 tons/acre; chloride and nitrate levels were excessive above a shallow layer of hardpan. Unaccountably, nitrogen was lacking for crop growth in the manured lysimeters at times.

1972-C053
KRUEGER, W. F. and HALL, C. F.
Effects of Processing Poultry Manure on Disease Agents
USDA CRIS Accession No. 0032670 2 p.

SPONSORING ORGANIZATION: Texas Ag. Ex. Sta.

OBJECTIVES: To investigate disease agents in dried and composted litter.

PROGRESS REPORT: "Reusing litter for a second brood of broilers had no effect on performance in these studies. . . Composted garbage was equal to pine shavings as an absorbent litter." The addition of fungicides and of some bacteria to the litter enhanced performance of broilers.

1972-C054
LARSON, G. H.
Farm Animal Waste Disposal
USDA CRIS Accession No. 0002287 3 p.

SPONSORING ORGANIZATION: Kansas Agr. Ex. Sta.

OBJECTIVES: "Improvement in management systems with regard to handling, treatment and disposition of wastes."

PROGRESS REPORT: Runoff from feedlots in a period of higher than normal natural rainfall, with the manure in the lots trampled into a slurry, contained concentrations of suspended solids almost double the previously recorded figures. "Field plots irrigated with feedlot runoff showed no apparent decrease in water intake rate and corn yields were the same for plots irrigated with runoff and others irrigated with well water and fertilized according to standard recommendations."

1972-C055
LARSON, Russell E.
Evaluation of Waste Handling Systems for Housed Large Animals in the North Central Region
USDA CRIS Accession No. 0020503 2 p.

SPONSORING ORGANIZATION: ARS Livestock Eng. and Farm Struct. Res.

OBJECTIVES: To "develop technology for efficient handling, storing, utilization and disposal of cattle wastes produced in confinement production systems."

PROGRESS REPORT: Performance of oxidation ditches subjected to various loadings under summer and winter conditions has been investigated.

1972-C056
LEIBHARDT, W. C. and MOREHART, A. L.
Effect of Poultry Manure on Crop Response, Soil Properties and Water Quality
USDA CRIS Accession No. 0060338 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Delaware

OBJECTIVES: To determine the effects on soil and water of large applications of poultry wastes.

PROGRESS REPORT: "Yield of corn dropped from 55 bu. per acre to 14 bu. per acre as the rate of manure application increased from 75 to 100 tons." Pathogenic fungi did not increase in soil treated with poultry litter.

1972-C057
LIPPER, Ralph I.
Animal Waste Management with Pollution Control
USDA CRIS Accession No. 0057539 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Kansas

OBJECTIVES: To investigate biological treatments to render cattle or swine manure more amenable to utilization or disposal, with emphasis on land disposal, evaporation, drying, and/or incineration.

PROGRESS REPORT: Nitrate concentrations in soil columns were measured. Studies are under way "to achieve an all liquid disposal system without the addition of water" on a covered cattle feedlot with a concrete floor sloping to a grated trench which, in turn, leads to a two-cell underground water-tight storage pit in which continuous mechanical stirring is maintained.

1972-C058
LIPPER, Ralph I. and MANGES, Harry L.
Farm Animal Waste Disposal
USDA CRIS Accession No. 0029482 3 p.

SPONSORING ORGANIZATION: Kansas Agr. Ex. Sta.

OBJECTIVES: To "test and demonstrate a system for the orderly disposal of stormwater runoff and solid wastes from beef animal commercial feedlots and to characterize the wastes generated."

PROGRESS REPORT: "When population density of cattle in test feedlots was doubled (400 head per acre vs. 200), the pollution potential of simulated stormwater runoff was increased by 25%. . . In a period of higher than normal natural rainfall, suspended solids in runoff when feedlot surfaces had been tramped into a slurry ran almost double the highest previously recorded values." Corn yields increased for manure loadings up to 20 tons/acre, remained constant for 20 to 160 tons/acre, and declined significantly at 320 tons/acre. "The pollution load of runoff from snowmelt was 3 to 4 times that from rainfall."

1972-C059
LOEHR, Raymond C.
Aeration Systems for Treatment of Animal Manures
USDA CRIS Accession No. 0061279 1 p.

SPONSORING ORGANIZATION: New York Ag. Ex. Sta.

OBJECTIVES: To "develop, refine and demonstrate the use of aeration systems for poultry wastes in pilot plant experiments." The oxidation ditch and rotating biological contactor will be investigated.

1972-C060
LOEHR, Raymond C. and SCHULTE, D. D.
Analytical Models for Animal Waste Management
USDA CRIS Accession No. 0031844 2 p.

SPONSORING ORGANIZATION: New York Ag. Ex. Sta.

OBJECTIVES: To "develop mathematical models capable of correlating the interrelationships of animal production to obtain adequate waste management."

PROGRESS REPORT: Dynamic programming was employed to optimize the treatment of duck farm wastewater economically.

1972-C061
LOEHR, Raymond C. and ZWERMAN, P. J.
Design Parameters for Animal Waste Treatment Systems
USDA CRIS Accession No. 0061606 1 p.

SPONSORING ORGANIZATION: New York Ag. Ex. Sta.

OBJECTIVES: To "demonstrate applicability of sanitary engineering fundamentals for design of aerobic biological treatment systems for animal waste. . ."

1972-C062
LONGHOUSE, A. D. and EMERSON, R. E.
Disposal and Utilization of Dairy and Poultry Manure by Land Application
USDA CRIS Accession No. 0031061 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, West Virginia

OBJECTIVES: To develop and evaluate disposal and utilization systems for land application of poultry manure.

PROGRESS REPORT: A scraper was developed for daily collection of manure from a layer house. Methods of drying are being studied.

1972-C063
LUDINGTON, D. C.
Systems for Alleviating Odors from Poultry Wastes
USDA CRIS Accession No. 0019901 2 p.

SPONSORING ORGANIZATION: ARS

OBJECTIVES: To determine the methods of poultry manure disposal having the most promise for incorporation into poultry production enterprises, particularly where odors are a major problem.

PROGRESS REPORT: "The removal of moisture is the most effective way of controlling the release of odors from chicken manure. . . Aeration is effective but appears to be more difficult to accomplish." Mechanical devices are being tested. An air velocity through the undercage drying system of 500 fpm appeared to be optimum.

1972-C064
LUDINGTON, D. C. and HASHIMOTO, A. G.
Drying and Storage of Poultry Manure
USDA CRIS Accession No. 0022861 1 p.

SPONSORING ORGANIZATION: New York Agr. Ex. Sta.

OBJECTIVES: To evaluate, on a field scale, two systems of drying poultry manure under caged laying hens. Guidelines for proper manure management will be developed.

1972-C065
LUND, Z. F. and PEARSON, R. W.
The Role of Soil in Farm Waste Management
USDA CRIS Accession No. 0021375 2 p.

SPONSORING ORGANIZATION: ARS

OBJECTIVES: To determine the effects of high application rates for manure

PROGRESS REPORT: "Soil treated with cattle manure at rates ranging from 40 to 120 tons dry matter per acre annually produced higher yields of millet and rye forage than where adequate mineral fertilization was used at Auburn, Alabama. . . Nitrate levels of the forage exceeded safe values for ruminants when manure was applied at rates above 40 tons dry matter per acre." The intake of heavy metals (Mn, Fe, and Zn) increased as manure application increased.

1972-C066
MANGES, Harry L.
Demonstration and Development of Facilities for Treatment and
Ultimate Disposal of Cattle Feedlot Wastes
USDA CRIS Accession No. 0056833 2 p.

SPONSORING ORGANIZATION: Kansas Agr. Ex. Sta.

OBJECTIVES: To determine characteristics of manure, determine the most economical loadings of manure and effluent on soil (considering pollution), and investigate health hazards involved.

PROGRESS REPORT: Salt buildups in the soil limited the feasible rates of disposal of manure and effluent. Storage reduced COD by up to 65 percent by settling of solids, but had little effect on total nitrogen and phosphorus.

1972-C067
MAYES, H. F.
Improve Methods, Equipment and Facilities for Handling Waste
Material from Livestock Markets and Feedlots
USDA CRIS Accession No. 0021021 2 p.

SPONSORING ORGANIZATION: Transportation/Facilities Div., ARS

OBJECTIVES: To "develop improved methods, equipment, devices and facilities for handling the waste materials from livestock markets and commercial feedlots."

PROGRESS REPORT: Land spreading is often impractical. Stockpiling results in drainage, seepage, and stormwater runoff with major resultant pollution. Some markets are drying manure for fertilizer. "Cost of dehydration is about equal to the wholesale selling price. Even though there is no profit in such an operation, it may still be the least expensive method of disposal. Dust and odor are problems yet to be solved in operating dehydrators."

1972-C068
McCALLA, T. M.; ELLIS, J. R.; and ELLIOTT, L. F.
Water and Soil Pollution from Beef Cattle Feedlots in Nebraska
USDA CRIS Accession No. 0031827 4 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Nebraska

OBJECTIVES: "To determine amounts and characteristics of pollutants being deposited on, in runoff from, in soil profile, and in ground water of beef cattle feedlots. . ."

PROGRESS REPORT: "Soil core samples from an extensive coring study generally show low NO_3-N beneath level, stocked feedlots." Vigorous metabolic activity by anaerobic bacteria occurs below feedlot surfaces. "It is reasonable to assume, when the feedlot is wet, nitrate will be reduced in the profile before it reaches the water table." The pollution potential of a feedlot is affected by surface conditions and stocking rate.

1972-C069
McCALLA, T. M. and SWANSON, N. P.
Management of Cattle Feedlots and Animal Wastes for Control of Soil Water and Air Pollution
USDA CRIS Accession No. 0020810 3 p.

SPONSORING ORGANIZATION: ARS

OBJECTIVES: To develop modified feedlot designs to minimize soil, water, and air pollution.

PROGRESS REPORT: Costs for cleaning and maintaining broad-basin terraces in new feedlot designs increase with ground slope from less than 25 cents per head per year on four- to eight-percent slopes to about a dollar on 15-percent slopes. "The profile below a flat feedlot remained anaerobic. The site poses no nitrate hazard to ground water."

1972-C070
MILLER, E. R.
Animal Waste Management with Pollution Control
USDA CRIS Accession No. 0059357 2 p.

SPONSORING ORGANIZATION: Cooperating State Research Service, Michigan

OBJECTIVES: To develop animal waste management systems for the treatment, conditioning, utilization and/or disposal of wastes.

PROGRESS REPORT: Utilization of feces from swine reared in confinement on self-cleaning floors as 22 percent of a cereal ration for swine gave a 1 lb per day gain, but with poor efficiency. Loin roasts had good flavor acceptability. Dried swine feces proved to be superior to dried poultry wastes for use in a swine finishing ration.

1972-C071
MILNE, C. M.
Feed and Waste Removal Structures for Livestock
USDA CRIS Accession No. 0003342 3 p.

SPONSORING ORGANIZATION: Montana Agr. Ex. Sta.

OBJECTIVES: To pump liquid manure and spread it in the field, making an economic study of the entire system.

PROGRESS REPORT: For a slatted floor beef cattle feedlot to function satisfactorily in a cold climate sufficient storage volume should be provided for a six-month supply of manure and bedding used should be of a type which may be included in a pumpable slurry. Commercially available equipment is adequate for pit cleaning.

1972-C072
MILNE, C. M.
Animal Waste Management with Pollution Control
USDA CRIS Accession No. 0056877 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Montana

OBJECTIVES: To optimize feedlot location for feed supply, waste disposal, transportation and similar factors.

PROGRESS REPORT: Wintering operations in which livestock are pastured in creek bottoms apparently cause no serious pollution problem. "Due to Montana's combination of desirable weather conditions, large land area and low population, the cattle industry can be encouraged to expand considerably, without becoming a pollution source, provided that feedlots are located properly and managed carefully."

1972-C073
MINER, J. Ronald and HAZEN, T. E.
Farm Animal Waste Disposal
USDA CRIS Accession No. 0030524 4 p.

SPONSORING ORGANIZATION: Iowa Ag. Ex. Sta.

OBJECTIVES: To investigate possible improvements in the efficiency of anaerobic digestion of manure.

PROGRESS REPORT: Data have been accumulated and analyzed for various operations and modifications of the 800-head swine finishing facility at Iowa State University and for various application rates of effluent from its anaerobic lagoon for irrigation.

1972-C074
MINER, J. Ronald; HAZEN, T. E.; and HAMMOND, E. G.
Animal Waste Management with Pollution Control
USDA CRIS Accession No. 0057712 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Iowa

OBJECTIVES: To study odors and their quantitative measurement. To evaluate the efficacy of water hyacinths for nutrient removal from diluted manure.

PROGRESS REPORT: Work is proceeding on odor collection and analysis. Water hyacinths, grown in a four-pool system, reduced nitrogen, phosphorus and organic matter concentrations sufficiently to permit discharge into surface waters.

1972-C075
MOORE, James A.; GOODRICH, P. R.; and DIESCH, S. L.
Farm Animal Waste Disposal
USDA CRIS Accession No. 0001695 3 p.

SPONSORING ORGANIZATION: Minnesota Ag. Ex. Sta.

OBJECTIVES: To evaluate the effectiveness of an oxidation ditch for treatment and partial digestion of beef cattle wastes under Minnesota climatic conditions.

PROGRESS REPORT: A batch oxidation ditch, of which the slurry reached a total solids concentration of 11.3 percent before becoming too viscous for adequate reaeration and circulation, operated through a Minnesota winter without major foaming problems. "The ditch was completely covered and exhaust heat from the housing kept the liquid above freezing."

"Solid material waste is being taken from the ditch and refed to the animals."

1972-C076
MORRISON, S. M.; MARTIN, R. P.; and WARD, J. C.
Animal Waste Management with Pollution Control
USDA CRIS Accession No. 0057695 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Colorado

OBJECTIVES: To study the effects of feed, additives, and bedding on runoff evaporation and solids disposal; to study enzyme activities in manure degradation; and to collect and analyze volatile pollutants above feedlots.

PROGRESS REPORT: Definitive studies have been completed on the salt content of manure and on the relation of runoff salinity to feed salt. Enzyme activity is under intensive study.

1972-C077
MULLINS, A. M. and TAYLOR, R. E.
Limited Aeration of Animal Wastes
USDA CRIS Accession No. 0059659 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Idaho

OBJECTIVES: To determine the ontimum volume and distribution of air which would prevent odor production in liquid manure storage pits while preserving, in as far as possible, the fertilizer value of the manure.

1972-C078
NANSON, R. S.
Microbial Oxidation of Methane
USDA CRIS Accession No. 0062111 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Wisconsin

OBJECTIVES: To develop fermentation systems for the production of useful products from waste methane.

PROGRESS REPORT: Strains of organisms capable of growth on methane as the sole carbon and energy source are being isolated and studied.

1972-C079
NELSON, W. E.
Reactions of Polyvalent Metals in Soil-Manure Systems
USDA CRIS Accession No. 0021305 1 p.

SPONSORING ORGANIZATION: ARS

OBJECTIVES: To relate heavy applications of manure to changes in polyvalent metals important in soil-plant relations.

PROGRESS REPORT: "Cattle manure over a wide range of application to a high-Mn soil did not result in increased water-soluble, easily-reducible to exchangeable Mn. . . There would be no danger of inducing Mn toxicity in crops by heavy manure applications."

1972-C080
NYE, J. C.
Biodegradation of Organic Waste
USDA CRIS Accession No. 0062092 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Indiana

OBJECTIVES: To study effects of such factors as temperature, time, composition, particle size, metals, salts, feed additives, and pesticides on the rate of biodegradation of animal waste.

1972-C081
PRATT, G. L.
Animal Waste Management with Pollution Control
USDA CRIS Accession No. 0057630 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, North Dakota

OBJECTIVES: To evaluate manure treatments in terms of water and air pollution control, labor requirements, and adaptability to cold climates.

PROGRESS REPORT: A cattle waste lagoon in Fargo "gave evidence, upon bacteriological, algal, and B.O.D. analyses, of a stable aerobic ecosystem during spring, summer, and fall seasons. During the winter months, when there was no algal growth, the lagoon reverted to a fermentative, anaerobic system and was less efficient as a mechanism for waste disposal."

Bacterial isolates showed marked resistance to antibiotics employed as animal feed. Moreover, this resistance was transferable to bacterial species sensitive to these antibiotics.

Samples of manure are being dried at 100, 200, 300 and 400°F. Fertility values and feed values of the dried manure are being measured.

1972-C082
PRATT, George L.
Feedyard Runoff
USDA CRIS Accession No. 0060203 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, North Dakota

OBJECTIVES: To determine the runoff rate from feedlots during spring thaws and summer rainstorms. To determine the pollution potential of feedlot runoff and to develop design criteria.

PROGRESS REPORT: Instrumented runoff collection systems have been installed in a 75-head dairy barn feedlot and in a paved feedyard for beef cattle.

1972-C083
REDDELL, D. L.
Water Quality Hydrology of Feedlot Waste Disposal Systems in Texas
USDA CRIS Accession No. 0058738 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Texas

OBJECTIVES: To determine hydrologic effects of large animal populations and to investigate the mechanisms of land disposal of manure.

PROGRESS REPORT: With manure applications of 0, 300, 600, and 900 tons/acre corn yields and forage sorghum yields were greatest at 300. Nitrate content increased with rate of application of manure.

1972-C084
RHODES, R. A.
Microbial Protein from Liquid Fraction of Feedlot Waste
USDA CRIS Accession No. 0022087 1 p.

SPONSORING ORGANIZATION: Northern Utilization Research Division, ARS

OBJECTIVES: To "develop a fermentative process to convert liquid feedlot waste into microbial protein suitable as a feed supplement."

PROGRESS REPORT: The liquid portion of feedlot waste contains microbially resistant material. The indigenous flora reduce COD and N by 70 to 80 percent in two or three days. Fungi and streptomycetes introduced experimentally reduced COD and N by only 50 to 60 percent "but the mycelium formed is readily recovered as a potential feed material." Added carbohydrates augment the reductions of COD and N.

1972-C085
ROSS, I. J.; BEGIN, J. J.; and JOHNSON, T. H.
Utilization of Manures as Sources of Nutrients for Animals
USDA CRIS Accession No. 0030515 3 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Kentucky

OBJECTIVES: To determine the effect of heat treatments, microbiological fermentation, and drying on the nutritional and feeding properties of animal manures.

PROGRESS REPORT: Feeding tests accompanied by an extensive battery of laboratory determinations are being undertaken to establish toxicity levels and growth response.

1972-C086
SCOTT, T. W.
Effects of High Application Rates of Manure to Soil on Crop Production and Water Quality
USDA CRIS Accession No. 0060453 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, New York

OBJECTIVES: To determine the maximum permissible rate of application of poultry manure to soils without affecting water quality or chemical composition of soil adversely.

PROGRESS REPORT: Greenhouse and field studies have been initiated.

1972-C087
SIMCO, J. S.
Control of Common Housefly
USDA CRIS Accession No. 0011512 3 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Arkansas

OBJECTIVES: To develop a housefly control program in all areas of agriculture based on minimal use of insecticides.

PROGRESS REPORT: Gardona capsules fed in a complete layer ration at the rate of 400 ppm were 95 percent effective for a four-week test period; at 200 ppm they were 75 percent effective.

1972-C088
SMITH, R. E.
Performance of the Inclined-Plane Trickling Filter for Aerobic Disposal of Animal Waste
USDA CRIS Accession No. 0056368 1 p.

SPONSORING ORGANIZATION: Georgia Ag. Ex. Sta.

OBJECTIVES: To develop a mathematical relation between slope, BOD, and contact time for a trickling filter treating animal wastes.

PROGRESS REPORT: By means of laboratory testing an equation has been developed for contact time for swine wastes. "It was concluded that the inclined-plane trickling filter can be beneficially used as a component in a waste handling system."

1972-C089
SMITH, R. E.
Design and Operation Criteria for an Anaerobic Lagoon for Swine Waste
USDA CRIS Accession No. 0056373 1 p.

SPONSORING ORGANIZATION: Georgia Agr. Ex. Sta.

OBJECTIVES: To design and construct an anaerobic lagoon, and obtain operating data on startup procedure, seepage losses, odor production, solids reduction, and BOD reduction.

PROGRESS REPORT: Permeability of the lagoon has decreased from 2 ft/day in 1969 to 0.5 ft/day at the end of 1971. An aerobic reactor for a second lagoon is giving trouble.

1972-C090
SOBEL, A. T.
Principles Applicable to the Handling and Land Application of Dairy Cow and Chicken Manure
USDA CRIS Accession No. 0006323 4 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, New York

OBJECTIVES: To develop feasible methods of handling manure at moisture contents not greater than those of the freshly produced manure.

PROGRESS REPORT: Air drying at velocities above 800 fpm cuts the time to approximately one-third. "There does not appear to be a correlation between humidity and drying time." Sealing of the surface appears to inhibit moisture flow to the surface.

1972-C091
STECKEL, J. E.
Disposal and Utilization of Dairy and Poultry Manures by Land Application
USDA CRIS Accession No. 0030591 4 p.

SPONSORING ORGANIZATION: Cooperating State Research Service, New Jersey

OBJECTIVES: To "study the application of liquid poultry manure by plow-furrow-cover and sub-sod injection methods."

PROGRESS REPORT: Results of chemical measurements following various applications and subject to reported precipitation are given. "The upper limit of poultry manure disposal in soil appears to be less than 34 metric tons (dry basis)/ha because of nutrient contamination in the soil water."

1972-C092
STEPHENS, G. R.; HILL, D. F.; and HANKIN, L.
Utilizing Liquid Poultry Wastes in Forests
USDA CRIS Accession No. 0058999 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Connecticut

OBJECTIVES: To determine a loading rate of poultry waste in forests which will endanger neither the vegetation nor groundwater and will not lead to fly breeding or aesthetic deterioration.

PROGRESS REPORT: Poultry manure spread at 17 tons/acre was dispersed by summer rains within two months. A 100-ton/acre application (five 20-ton applications at two-week intervals) dried to a persistent crust that supported abundant weeds. "Viable fly eggs placed on fresh manure survived poorly."

1972-C093
STEWART, B. A.
Disposal of Animal Wastes by Agricultural Practices in the Southern Plains
USDA CRIS Accession No. 0020803 2 p.

SPONSORING ORGANIZATION: SWC Research Division, ARS

OBJECTIVES: To determine the maximum quantity of manure that can be applied without impairing crop production and to measure pollutants moving through soil loaded at high rates.

PROGRESS REPORT: Plots have been loaded with 0, 10, 30, 60, 120, and 240 tons of manure per acre. Irrigation applied prior to seeding diluted salts and ammonium concentrations to levels that did not affect yields except at loadings of 120 and 240 tons/acre. Nitrate accumulated in the soil at loadings of 30 tons/acre and higher. Pollution hazards exist unless the crop utilizes most of the applied nitrogen. Playa lakes may be a real asset to the feeding industry due to their impermeable beds. Further research on this subject is required.

1972-C094
SUTTON, A. L.
Factors Influencing Animal Waste Management Systems
USDA CRIS Accession No. 0061964 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Indiana

OBJECTIVES: To evaluate environmental influences of waste management systems on animal productivity, to investigate effects of diet and system of waste management on composition and quantity of animal wastes, and to study effects of land application rates.

1972-C095
SWADER, F.
Determining Manure Loading Limits on Soil
USDA CRIS Accession No. 0022245 1 p.

SPONSORING ORGANIZATION: ARS

OBJECTIVES: To "determine the effects of high loading rates of manure on soil physical properties."

1972-C096
TAIGANIDES, E. Paul and WHITE, Richard K.
Farm Animal Waste Disposal
USDA CRIS Accession No. 0030168 3 p.

SPONSORING ORGANIZATION: Ohio Ag. Ex. Sta.

OBJECTIVES: "Processes to be considered for investigation are field spreading of liquid manure, decomposition at low temperatures, incineration, aeration, algae production, coprophagy, sterilization drying at high temperature, etc."

PROGRESS REPORT: Results of analyses of runoff quality, soil characteristics as affected by spreading practices, odor measurements, and characteristics of wastes are reported. The Botkins Automated Waste Treatment Plant has been completed and is operating satisfactorily at peak efficiency. Pyrolysis has been investigated.

1972-C097
THOMAS, C. H.
Lagoons for Disposal of Barn Yard Wastes
USDA CRIS Accession No. 0001265 4 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Louisiana

OBJECTIVES: To determine the feasibility of disposing of animal waste by means of lagoons in the climatic conditions found in Louisiana.

PROGRESS REPORT: Lagoons have performed well on both poultry and swine wastes. In a four-year period 5224 hens had been housed over an aerated lagoon; they had left 36,558 lb (dry basis) of manure, or 7 lb/hen-year, without odor problems resulting. Two swine lagoons, based on 35 and 45 sq ft of surface per 100 lb of hog, operated continuously for four and five years with little sludge accumulation, no cleaning, and no odors. Other data are reported.

1972-C098
THOMAS, J. W.
Animal Waste Management with Pollution Control
USDA CRIS Accession No. 0060201 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Michigan

OBJECTIVES: To evaluate the potential of animal wastes as a source of protein and energy when fed to ruminants.

PROGRESS REPORT: Sheep readily consumed rations containing 20 to 80 percent dehydrated caged layer feces. Rations containing ruminant feces were less digestible than rations containing poultry or swine feces. Sheep make reasonable weight gains on 25 percent DPW. Milking cows can be fed 30 percent DPW without affecting the flavor of the milk. They will refuse grain rations containing 50 percent DPW.

1972-C099
TURK, M.
Production of Power Fuel by Anaerobic Digestion of Feedlot Waste
USDA CRIS Accession No. 0022215 1 p.

SPONSORING ORGANIZATIONS: ARS, Hamilton Standard

OBJECTIVES: To study generation of fuel gas by anaerobic digestion of feedlot waste to determine if continuous process is feasible.

PROGRESS REPORT: "Cattle feedlot waste at 10% solids concentration can be digested in continuous anaerobic fermentation at feed rates between 0.5 and 1.0 pounds of volatile solids per cubic foot digester per day with a residence time of 6.25 days. The optimum temperature is 49°-51°C. . . No significant loss of nitrogen occurs in the gas. Methane production is 3-4 cubic feet per pound volatile solids introduced. . . Digestion and gas production have been consistent for 9 months of continuous operation."

1972-C100
UPDEGRAFF, D. M.
Specific Composition of Representative Feedlot Wastes
USDA CRIS Accession No. 0022211 1 p.

SPONSORING ORGANIZATION: Univ. of Denver

OBJECTIVES: To determine the biologically important compounds present in manure from cattle and hog feedlots and determine the causes of their variations.

PROGRESS REPORT: Ratios of COD/BOD of from 2.5:1 to 9:1 reflect the high concentration of organic matter refractory to microbial oxidation. Few, if any, Salmonellae have been found in the samples analyzed.

1972-C101
VIETS, F. G., Jr. and HAISE, H. R.
Management of Animal Wastes and Feedlots to Avoid Soil and Water Pollution
USDA CRIS Accession No. 0020809 3 p.

SPONSORING ORGANIZATION: ARS

OBJECTIVES: To evaluate feedlot runoff.

PROGRESS REPORT: Two commercial feedlots were instrumented and lysimeter tests were conducted to determine quantity and quality of runoff and percolation. In the case of a level site "percolate represented only 3.4 percent of the total waste delivered to the lot." On a sloping lot is would be much less. "Water-soluble organics in feedlot manures do not penetrate far below the surface."

1972-C102
VIETS, F. G., Jr. and OLSEN, S. R.
Soil Fertility Maintenance with Fertilizers, Crop Residues, and Animal Wastes
USDA CRIS Accession No. 0020858 3 p.

SPONSORING ORGANIZATION: ARS

OBJECTIVES: To evaluate the fertilizer value of manure.

PROGRESS REPORT: "Feedlot manure in a greenhouse experiment was an excellent source of P and S for plant growth, but a poor source of N, Fe, and Zn."

1972-C103
WALKER, H. G., Jr. and GRAHAM, R. P.
Development of Processes for Improved Feeds from Agricultural Wastes
USDA CRIS Accession No. 0021338 2 p.

SPONSORING ORGANIZATION: Western Utilization Research Division, ARS

OBJECTIVES: Convert lignified agricultural residues into useful animal feeds.

PROGRESS REPORT: A 12 cu ft pressure reactor capable of handling 30 to 60 lb samples at steam pressures up to 400 psig is being used to modify digestibilities of various wastes preparatory to feeding tests. Early work was on grass and cereal straws. Tests on animal wastes are contemplated.

1972-C104
WESTBROOK. F. E.
Management of Animal Manure on Cropland
USDA CRIS Accession No. 0022295 1 p.

SPONSORING ORGANIZATION: ARS

OBJECTIVES: To "determine the effects of high rates of animal manure on soil properties, crop yield, and crop quality."

1972-C105
WIERSMA, F.
Animal Waste Management with Pollution Control
USDA CRIS Accession No. 0057679 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Arizona

OBJECTIVES: To develop management systems to controlodors and dust from feedlots.

PROGRESS REPORT: Tests on 44 plots covered with pulverized manure and agitated to simulate cattle traffic indicate that chemical treatments (calcium nitrate and glycerol) are ineffective. For a given amount of water, application once per day is more effective than small applications throughout the day.

1972-C106
WIERSMA, J. L.; DITTMAN, A.; and MADDEN, J.
Evaluation of Systems for Disposal of Livestock Wastes
USDA CRIS Accession No. 0060278 1 p.

SPONSORING ORGANIZATION: South Dakota Ag. Ex. Sta.

OBJECTIVES: To determine the degree of treatment obtained and costs involved in various feeding and waste handling systems at feedlots.

PROGRESS REPORT: Construction and instrumentation of two feedlots for comparative studies was nearing completion in 1971.

1972-C107
WILKINSON, S. R.
Poultry Manure Management on Farmlands in the Southeast
USDA CRIS Accession No. 0020806 3 p.

SPONSORING ORGANIZATION: ARS

OBJECTIVES: To determine the effects of applications of up to 200 tons per acre per year of poultry manure to small plots.

PROGRESS REPORT: Results are summarized for a series of tests. Coastal bermudagrass will tolerate three to four times as much broiler litter as will tall fescue. "Ton yields of Coastal bermudagrass were obtained with four 20-ton per acre applications of litter." The problem of fat necrosis in cattle herds in not associated with the effects of poultry litter per se, but rather with the high nutrient content often involved.

1972-C108
WILSON, J. D.
Management of an Oxidation Ditch for a Swine Confinement Feeding Facility
USDA CRIS Accession No. 0055122 2 p.

SPONSORING ORGANIZATION: Georgia Ag. Ex. Sta.

OBJECTIVES: To establish criteria for the design of oxidation ditch systems for new or existing swine finishing facilities.

PROGRESS REPORT: Analyses of solids and liquids in the ditch have been made during and after use for hogs. Mechanical modifications to eliminate spots with zero or low velocities, to reduce belt slippage, and to reduce bearing wear and corrosion have improved ditch efficiency.

1972-C109
YOUNG, E. P.; INGLING, A. L.; and DEBARTHE, J. V.
Pollution Potential of Run-off from Areas Affected by Domestic Animal Wastes
USDA CRIS Accession No. 0062033 1 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Maryland

OBJECTIVES: To determine the kinetics of bacterial contamination of streams enriched by runoff from grazing areas.

PROGRESS REPORT: Dissolved nutrients, dissolved oxygen, COD, bacterial loading, total coliforms, temperatures and other water characteristics will be measured and correlated with animal stocking densities and weather data.

1972-C110
ZINDEL, Howard C.
Animal Waste Management with Pollution Control
USDA CRIS Accession No. 0057925 2 p.

SPONSORING ORGANIZATION: Cooperative State Research Service, Michigan

OBJECTIVES: To study the treatment and conditioning of wastes for utilization or disposal with attention being directed to economic, biological, and physical analysis.

PROGRESS REPORT: "Excreta from laying hens was dehydrated and re-fed to the same laying hens at either 12-1/2 or 25 percent of the ration in the place of corn. After 23 consecutive recycling periods, there was no difference in egg production or mortality of those birds fed the dried poultry excreta when these parameters were compared with birds fed a control ration." Earlier tests had established that "the addition of 3% fish meal or 8% DPW gave equal growth responses which were 27% greater than the controls."

1972-C111
ZINDEL, Howard C.
Evaluation of the Nutritive Value of Wastes for Poultry
USDA CRIS Accession No. 0059078 1 p.

SPONSORING ORGANIZATION: Mich. Ag. Ex. Sta.

OBJECTIVES: To assess the value of, and drug transfer from, dehydrated poultry wastes.

PROGRESS REPORT: Seven different samples of dried poultry waste are being evaluated. Feeding trials and chemical analyses have been completed.

APPENDIX D

INDEXES OF ABSTRACTS

The 1162 abstracts of Appendix A and the 111 of Appendix C are indexed first by author and then, in a separate alphabetical list, by subject. The author index includes all authors of multiple-author papers, discussers, and all individuals cited in the abstracts.

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1964-1004; 1967-1004; 1968-1008; 1969-1014; 1972-C014

DIESCH, Stanley L.
1971-1070, 1071; 1972-1033, C075

DIGGS, B. G.
1965-1007

DINIUS, D. A.
1971-1072, 1254

DITTMAN, A.
1972-C106

DOBSON, J. W., Jr.
1972-C029

DODD, J. D.
1971-1180

DOLL, Raymond J.
1972-1034

DOMINICK, David D.
1971-1073

DONDERO, Norman C.
1969-1015; 1970-1011; 1972-C030

DONEEN, L. D.
1966-1023

DORN, D. A.
1971-1089, 1226; 1972-1045, 1190, 1208

DORNBUSH, James N.
1970-1018, 1111; 1971-1162

DOROUGH, H. W.
1961-1004

DOUGLASS, M. P.
1969-1023

DRAKE, C. L.
1965-1008; 1966-1029

DRAZEK, P. A.
1970-1064

DRUMMOND, R. O.
1963-1004

DRYSDALE, A. D.
1962-1002; 1966-1014, 1024

DUFFER, William R.
1970-1083; 1971-1074

DUGAN, Gordon L.
1968-1014; 1972-1035

DUNAWAY, Bob
1971-1075, 1076

DUNLAP, C. E.
1971-1046

DUNN, G. G.
1972-1036; 1973-1027

DURAN, Alvaro
1970-1015

DURFEE, W. K.
1972-C031

DURHAM, R. M.
1966-1025

DYMOND, G. C.
1949-1001, 1004

EARL, George A., Jr.
1972-1037

EASTWOOD, Roy E.
1967-1005

EBY, Harry J.
1962-1003; 1965-1010; 1966-1026, 1027; 1969-1024; 1971-1049; 1973-1024

EDDY, Gaines W.
1961-1005

EDEN, A.
1940-1001

EDWARDS, Douglas H.
1972-1029

EDWARDS, H. M., Jr.
1960-1006

EDWARDS, J. B.
1969-1025; 1972-1038; 1973-1027

EDWARDS, W. M.
1971-1077; 1972-1166

EFTINK, Bill
1971-1078

EICHE, Carl
1971-1079, 1080, 1081, 1082; 1972-1039, 1040, 1041

ELAM, C. J.
1972-1164, 1165

ELAM, F. Leland
1972-1042

ELAM, J. F.
1954-1001, 1002

ELAM, Lee
1971-1083

ELAM, M. L.
1973-1010

ELLINGTON, Gary
1972-1123

ELLIOTT, L. F.
1971-1165; 1972-1094, C068

ELLIS, B. G.
1972-1043

ELLIS, D.
1972-1171

ELLIS, J. R.
1971-1101, 1102, 1103, 1240; 1972-1052, 1094, 1105, C068

ELMUND, G. Keith
1971-1084

EL-SABBAN, F. F.
1968-1015; 1969-1026; 1970-1019

EMERSON, R. E.
1972-C062

ENGLISH, P. R.
1971-1204

EPSTEIN, E.
1972-C050

ERHARDT, W. H.
1971-1127

ERICKSON, A. E.
1972-1043

ERWIN, Gene
1970-1117

ESMAY, Merle L.
1971-1085

ESSICK, Lloyd
1971-1028

EVANS, Sam
1972-1182

EXON, J. James
1971-1086

FAIRBAIRN, C. B.
1970-1135

FAIRBANK, W. C.
1970-1075

FARNHAM. R. S.
1972-C001

FARR, F. M.
1973-1008

FEE, Rodney J.
1971-1087

FELD, I. L.
1972-1032

FELDMANN, M.
1971-1252

FELDMAN, H. F.
1971-1088

FENG, T. H.
1969-1021

FENNER, H.
1959-1004

FÉRAUD, M.
1951-1001

FERGUSON, T. L.
1972-1049

FETTEROLF, Jerry
1972-1044

FIALA, Grace
1959-1001; 1963-1002

FINA, L. R.
1966-1050, 1051; 1967-1016

FINCHER, G. Truman
1970-1020

FISH, H.
1964-1006

FLEGAL, Cal J.
1969-1027; 1970-1021, 1022, 1023, 1024, 1085, 1110; 1971-1039, 1089, 1090, 1208, 1226, 1238, 1251, 1275; 1972-1045, 1159, 1190, 1208, C032

FLEMING, Bill
1970-1025; 1971-1091, 1092

FOERSTER, E. L., Sr.
1966-1028

FOGG, Charles E.
1971-1093

FONTENOT, J. P.
1964-1003; 1965-1003, 1008; 1966-1009, 1029; 1970-1026, 1031; 1971-1094, 1095, 1251; 1972-1063, 1064; 1973-1006, 1012, 1039

FORD, B. F.
1955-1001

FOREE, Gerald R.
1969-1028

FOSGATE, O. T.
1972-1046

FOSS, J. E.
1972-C006

FOWLER, Bob
1968-1038

FOWLER, Jean
1954-1002

FOX, W. R.
1971-1321

FRAIPONT, Delwyn R.
1972-1029

FRANKL, Gerald
1971-1286, 1289, 1291; 1972-1160, 1178, 1179

FREAR, D. E. H.
1968-1015; 1969-1026, 1048; 1970-1019

FREDERICK, L. R.
1969-1050

FREY, L. J.
1961-1006

FRIEDMAN, Sam
1971-1015; 1972-1047

FRIES, G. F.
1973-1034

FRINK, C. R.
1970-1027

FRITSCHI, E. W.
1971-1096

FROBISH, L. T.
1971-1097, 1254

FU, Y. C.
1971-1015; 1972-1048

FULLER, Henry L.
1959-1007; 1960-1006

FUNK, J. W.
1966-1050, 1051

GAITHER, E. W.
1912-1001

GALLER, William S.
1971-1098, 1099

GARDNER, F. A.
1973-1008

GARNER, George B.
1971-1215

GARNER, William
1972-1049; 1973-1011

GARRIGUS, Upson S.
1971-1138

GARTLEY, K. M.
1949-1003

GARTON, J. E.
1971-1043, 1044; 1972-1021

GASKINS, Charles T.
1973-1015

GATES, Charles D.
1963-1005

GEHLBACH, Albert E.
1972-1050

GELDREICH, E. E.
1962-1004

GENETELLI, Emil J.
1969-1082; 1971-1058; 1972-C033

GENTRY, R. F.
1968-1015; 1969-1026; 1970-1019

GEORGE, Robert M.
1971-1215; 1972-1176; 1973-1041, 1049

GERRISH, J. B.
1972-C034

GERRY, R. W.
1968-1016; 1972-C035

GEYER, Richard E.
1971-1146

GIBBONS, J.
1968-1017

GIDDENS, J. E.
1972-C036

GILBERTSON, Conrad B.
1971-1100, 1101, 1102, 1103, 1239; 1972-1051, 1052, 1105, 1134, 1177, C023, C037, C038

GILBERTSON, Wesley E.
1966-1030

GILLHAM, R. W.
1969-1029

GILLILAND, Jay
1970-1028

GILMOUR, C. M.
1972-C039

GINSBERG, Henry H.
1972-1047

GISH, P. T.
1958-1002

GLASSEY, C. R.
1972-1106

GLERUM, J. C.
1971-1104

GOAN, H. C.
1970-1021, 1085

GOATER, J. C.
1968-1008; 1969-1014

GOERING, H. K.
1969-1078; 1970-1086; 1971-1229, 1230

GOJMERAC, Walter
1971-1105; 1972-1213

GOLDHAFT, Tevis M.
1969-1076

GOLUEKE, Clarence G.
1965-1009; 1966-1023, 1031; 1968-1014; 1970-1029, 1030; 1971-1106; 1972-1035, 1053, 1054, 1055, 1106

GOMEZ, M.
1971-1208

GOODRICH, Phillip R.
1971-1107; 1972-C075

GORDON, Chester H.
1969-1078; 1970-1064, 1065, 1066, 1086; 1971-1229, 1230, 1231, 1313

GORDY, J. F.
1968-1011

GORMEL, B.
1971-1159

GOWAN, Douglas J. B.
1969-1090, 1091; 1971-1108

GOWDY, Billy Ray
1971-1109

GRAHAM, David B.
1971-1310; 1972-1056

GRAHAM, R. P.
1972-C103

GRAMMS, L. C.
1971-1110

GRANT, D. W.
1971-1084

GRAU, C. R.
1957-1001

GRAVES, Quintin B.
1969-1041

GRAVES, R. E.
1971-1111

GREATHOUSE, T. R.
1972-C040

GREENE, L. M.
1968-1011

GRIEL, L. C., Jr.
1969-1030

GRIMM, Alfred
1972-1057

GROOMS, Randall D.
1972-1156

GROSCHKE, A. C.
1947-1001; 1948-1002

GROSS, Champ
1971-1112

GROSSMANN, E. D.
1971-1250

GROVES, Wil
1971-1113, 1114, 1115, 1116; 1972-1058, 1059

GRUB, Walter
1968-1018, 1019; 1969-1031, 1032, 1068, 1086, 1087, 1088; 1970-1041, 1059, 1102; 1971-1007, 1057, 1117, 1258

GRUMMER, R. H.
1943-1002

HADDER, A. W.
1966-1020

HAGHIRI, F.
1972-C041

HAISE, H. R.
1972-C101

HALE, E. B.
1971-1259

HALE, O. M.
1958-1003

HALE, W. F.
1966-1034

HALE, W. S.
1971-1236

HALL, C. F.
1972-C053

HALLIGAN, James E.
1972-1060, 1218; 1973-1013, 1044

HAMILTON, Harvey E.
1971-1118, 1310; 1972-1133

HAMMER, U. T.
1972-1061

HAMMOND, E. G.
1972-C074

HAMMOND, John C.
1942-1002, 1003; 1944-1001, 1002

HANCOCK, Randolph S.
1956-1002

HANKIN, L.
1972-C007, C092

HANKS, Thrift G.
1967-1006

HANSEN, C. M.
1958-1001; 1972-1043

HANSEN, Edwin L.
1971-1067

HANSEN, K. R.
1972-1080

HANSEN, R. W.
1969-1065; 1972-C042

HARGROVE, Tom
1971-1119

HARLIN, Curtis C., Jr.
1971-1074

HARKNESS, R. E.
1969-1069

HARMON, B. G.
1969-1033; 1971-1120; 1972-1062, C043

HARMON, B. W.
1970-1026, 1031; 1971-1095; 1972-1063, 1064; 1973-1012, 1039

HARMS, Robert H.
1966-1003; 1968-1020

HARPER, Jerome P.
1971-1185

HARROLD, L. L.
1971-1077

HART, Samuel A.
1960-1002; 1963-1006,
1007, 1008; 1964-1007,
1008, 1009, 1013; 1965-
1009, 1010, 1011; 1966-
1023, 1032, 1033, 1034;
1968-1021; 1970-1032,
1111; 1971-1121

HARTMAN, Roland C.
1963-1009; 1970-1033;
1971-1122, 1123, 1124;
1972-1065

HASHIMOTO, A. G.
1971-1160; 1972-1095,
C013, C044, C064

HAYNES, S. K.
1946-1002

HAZEN, Thamon E.
1963-1012; 1964-1021;
1966-1072; 1969-1034;
1970-1068; 1971-1125,
1145, 1232; 1972-1016,
1082, 1088, C073, C074

HEATH, Milton S., Jr.
1971-1126

HEGG, Richard O.
1972-1066

HEGNER, J. R.
1963-1003

HEIDAR, Farouk A.
1971-1185

HEINEMANN, Heinz
1965-1020

HEITMAN, H., Jr.
1966-1035

HEITMAN, R. N.
1968-1008

HEITSCHMIDT, Bobby C.
1971-1028

HENDERSON, Hugh E.
1971-1039, 1040

HENDERSON, John M.
1962-1005

HENSLER, R. F.
1970-1034; 1971-1127

HENTGES, J. F., Jr.
1972-1067, 1151

HEPHERD, R. O.
1971-1128

HERMAN, L. G.
1971-1003

HERMANSON, R. E.
1972-C045

HERNANDEZ, John W.
1971-1129

HERR, Glenn H.
1970-1035, 1036, 1037,
1113

HERRICK, John B.
1971-1130, 1131; 1972-
1068

HERRICK, R. B.
1972-C046

HERZOG, K. L.
1973-1013

HESLER, J. C.
1972-1114

HICKEY, John L. S.
1962-1007

HILEMAN, L. H.
1967-1007; 1971-1132; 1972-C047; 1973-1014

HILL, D. C.
1949-1003

HILL, David E.
1971-1236, 1322

HILL, D. F.
1972-C092

HILL, D. T.
1972-1012

HILL, M. E.
1972-1162

HINDS, F. C.
1972-1028

HINES, N. William
1969-1035

HINTZ, H. F.
1966-1035

HOBBS, Charles S.
1966-1036

HOBGOOD, Price
1971-1212

HODGETTS, Brian
1971-1114, 1133, 1251; 1972-1069

HOFFER, J. A.
1970-1097

HOGLUND, C. R.
1972-1073

HOLLEMAN, K. A.
1971-1134

HOLMES, Lloyd W. J.
1971-1114, 1135

HOLMES, R. G.
1972-C049

HOOVEN, Norman W.
1961-1001

HORE, F. R.
1971-1252

HORTENSTINE, C. C.
1971-1186, 1201

HOVENDEN, Tom
1970-1038

HOWARD, Albert
1972-1055

HOWE, L. G.
1966-1025

HOWELL, E. S.
1972-C048

HOWELLS, David H.
1971-1216, 1217; 1972-1130

HOWES, James R.
1966-1037; 1968-1022, 1023; 1971-1136

HUFF, C. B.
1962-1004

HUISINGH, D.
1972-1070

HUMENIK, F. J.
1971-1016; 1972-1070, C049

HUMMEL, J. W.
1972-1168

HUTCHINSON, G. L.
1967-1023

HUTCHINSON, T. H.
1962-1006

HYSLOP, N. St. G.
1970-1039

IBARBIA, Ramon
1966-1061

IDNANI, M. A.
1971-1148

ILLIG, E. G.
1972-1048

INGLING, A. L.
1972-C109

INGRAM, S. H.
1973-1015

IRGENS, R. L.
1966-1038, 1039

JACKSON, Sally W.
1970-1040; 1971-1118

JACKSON, W. A.
1971-1262

JACOBS, G. B.
1965-1013

JACOBS, R. L.
1954-1001, 1002

JAEGER, G. B.
1966-1011; 1972-1071

JAKOBSON, Kurt
1973-1016

JAMES, Frank
1965-1007

JANSE, J. F.
1970-1098

JAWORSKI, Norbert A.
1962-1007

JEDELE, D. G.
1959-1005; 1971-1137

JEFFREY, E. A.
1965-1012

JENKINS, W. R.
1970-1131

JENSEN, A. H.
1969-1033; 1971-1066, 1067, 1120; 1972-1062, C043

JEWITT, T. N.
1949-1002

JEX, E. M.
1969-1084

JOHANNES, R. F.
1970-1034

JOHNSON, Curtis A.
1965-1013, 1014, 1015

JOHNSON, H. P.
1964-1021

JOHNSON, Henry
1971-1152

JOHNSON, Hugh S.
1972-1072

JOHNSON, J. B.
1972-1073

JOHNSON, Ronald R.
1972-1074, 1216

JOHNSON, Thomas H.
1969-1036, 1037; 1970-1040, 1067; 1972-C085

JOHNSON, W. A.
1968-1043

JOHNSON, W. H.
1971-1212

JOHNSTON, Gene
1973-1017

JONES, Benjamin A., Jr.
1968-1024; 1971-1062

JONES, C. D.
1973-1015

JONES, Don D.
1968-1013, 1024; 1969-1038; 1971-1067, 1138; 1972-1075

JONES, E. E.
1946-1003

JONES, Elmer E., Jr.
1971-1139

JONES, J. B., Jr.
1971-1262

JONES, Ken B. C.
1969-1091; 1971-1140, 1141

JONES, P. H.
1969-1039; 1972-1076

JOO, Y. D.
1973-1019

JORDAN, Herbert C.
1966-1040; 1970-1134; 1971-1142

JORDAN, J. R.
1972-1111

JOST, Gary
1971-1303

KABLER, P. W.
1962-1004

KADA, Jimmy M.
1967-1005

KAMBHU, Kawi
1971-1012

KAMPELMACHER, E. H.
1971-1143

KAPPE, David S.
1972-1077

KARCZMARCZYK, S.
1972-1162

KEARL, C. D.
1969-1051

KEEN, Montague
1969-1040

KEENE, Alvin G.
1971-1152

KEETON, L. L.
1970-1041

KEHR, William Q.
1970-1042

KELLOGG, W. L.
1948-1001

KEMPER, W. D.
1967-1023

KENNARD, D. C.
1948-1003; 1954-1003

KERR, H. A.
1966-1048

KERSHAW, Charles
1971-1292

KERSHAW, Richard
1971-1292

KESLER, Richard P.
1966-1041

KETCHESON, J. W.
1969-1022

KIESNER, Jack
1971-1144; 1972-1078

KIMBARK, John
1968-1025

KING, T. B.
1966-1064

KING, Thomas
1970-1043, 1113

KIRK, J. K.
1967-1008

KISSAM, J. B.
1971-1134

KITTRIDGE, C. W.
1966-1011; 1972-1071

KLAUSNER, S. D.
1972-1171

KLEIN, N. W.
1957-1001

KLEIN, S. A.
1972-1079, 1106

KLETT, R. Hollis
1972-1080; 1973-1018

KLINGE, A. F.
1972-C050

KLIPPLE, G. E.
1959-1006

KLOMP, G.
1971-1104

KLOPFENSTEIN, Lynn
1972-1006

KLOSTERMAN, E. W.
1971-1167; 1972-C051

KNAPP, Carol E.
1970-1044

KNAPP, George L.
1972-1081

KNECHT, Robert W.
1970-1045

KNIGHT, David W.
1970-1054; 1973-1003

KOELLIKER, J. K.
1970-1046; 1971-1145;
1972-1082

KOLEGA, John J.
1969-1041; 1972-C052

KOTTMAN, Roy M.
1971-1146

KRADEL, D. C.
1969-1030

KREHER, Henry J.
1972-1083

KREIS, R. Douglas
1970-1083; 1971-1074;
1972-1084, 1085

KRIEL, H. T.
1945-1001

KRIZ, George J.
1971-1016, 1216, 1217;
1972-1130

KRONEBERGER, G. F.
1972-1086

KROONTJE, Wybe
1958-1002

KROPP, Virgil L.
1964-1025

KRUEGER, W. F.
1972-C053

KU, P. K.
1971-1194

KUMAR, M.
1972-1087

KVIDERA, Ferdinand
1971-1286

KWONG, Eva
1963-1002

LAAK, R.
1970-1047

LA BRECQUE, G. C.
1960-1003

LACY, H. O.
1967-1009

LAMOREAUX, W. F.
1940-1002

LANE, T. H.
1967-1010; 1969-1085

LANGLOIS, B. E.
1970-1040

LANGSTON, Walter
1971-1318

LARSON, G. H.
1966-1050; 1972-C054

LARSON, Russell E.
1969-1062; 1970-1048, 1113; 1971-1147; 1972-1066, 1088, C055

LaSALLE, Robert M., Jr.
1969-1042

LAUNDER, Mark
1969-1042

LAURA, R. D.
1971-1148

LAUSER, Greg
1971-1149

LAW, James P., Jr.
1969-1043; 1970-1049

LAWSON, Larry G.
1971-1150

LEE, Hong Y.
1971-1151

LEE, Y. N.
1971-1037

LEFKE, Louis W.
1971-1152

LEHNER, Richard
1965-1022

LEIBHARDT, W. C.
1972-C056

LEMAN, Allen D.
1967-1011

LENNON, A. Max
1973-1015

LEVI, Donald R.
1972-1089

LEWINGTON, Peter
1964-1010; 1965-1016

LEWIS, J. M.
1972-1028

LIBBY, David
1971-1274

LIBKE, K. G.
1970-1026; 1973-1039

LIGGETT, Lyle
1971-1153

LIGHT, R. G.
1971-1111

LILLIE, Robert J.
1948-1004

LIN, Shundar
1972-1090

LINDER, Bob
1972-1178

LINDLEY, J. A.
1969-1023

LINDSAY, W. L.
1969-1057

LINGLE, J. C.
1968-1001

LINN, Alan
1966-1042

LINTON, R. E.
1969-1044

LIPPER, Ralph I.
1966-1050, 1051; 1969-1034, 1075; 1972-C057, C058

LIPSTEIN, Bianka
1971-1154

LITTLE, F. J.
1966-1043

LITTLE, J. A.
1971-1166

LIVSHUTZ, A.
1964-1011

LLOYD, L. E.
1967-1022

LLOYD, R. W.
1968-1011

LOEHR, Raymond C.
1966-1001; 1967-1012, 1013, 1014; 1968-1026, 1027; 1969-1045, 1046, 1047; 1970-1050, 1051, 1052, 1053, 1111; 1971-1155, 1156, 1157, 1158, 1198, 1222; 1972-1091, 1092, 1095, C059, C060, C061; 1973-1011, 1019

LOFGREEN, G. P.
1971-1183

LOGIVDICE, Albert S.
1965-1020

LONCHAMBON, Raymonde
1952-1001

LONG, T. A.
1966-1064; 1968-1007, 1015; 1969-1026, 1048; 1970-1019; 1972-1136

LONGHOUSE, A. D.
1972-1093, C062

LOOMIS, E. C.
1966-1006

LORIMOR, J. C.
1971-1240; 1972-1094

LOVETT, Joseph
1971-1171

LOWMAN, B. G.
1969-1049; 1970-1054

LUDINGTON, David, C.
1966-1044, 1068; 1967-1003; 1968-1049; 1971-1159, 1160; 1972-1095, C063, C064

LUDORF, R.
1948-1005

LUKE, George W.
1970-1055

LUND, Z. F.
1972-C065

LUNIN, Jesse
    1971-1161

LUTZ, J. F.
    1967-1003

LUTZ, Ron
    1972-1096

LYERLY, P. J.
    1971-1212

LYNN, H. P.
    1973-1002

MacARTHUR, Joseph
    1971-1250

MacDONALD, F. W.
    1966-1045; 1971-1096

MACKENZIE, J. D.
    1971-1292; 1972-1187

MACKEY, D. R.
    1972-1097

MACKSON, C. J.
    1966-1056; 1970-1016, 1085

MACLINN, Walter A.
    1970-1056

MacMILLAN, Keith
    1972-1098

MADDEN, John M.
    1971-1162; 1972-C106

MAHONEY, G. W. A.
    1971-1043, 1044; 1972-1021, C016

MALIK, D. D.
    1966-1061

MANDER, C. E.
    1972-1099

MANGES, Harry L.
    1971-1163; 1972-1115, 1180, C058, C066

MANNERING, J. V.
    1972-1203

MANTHEY, Earl W.
    1972-1100

MARRIOTT, L. F.
    1971-1021; 1972-1101

MARSDEN, S. J.
    1948-1001

MARTIN, John H., Jr.
    1972-1102

MARTIN, J. P.
    1973-1046

MARTIN, M. S.
    1970-1064

MARTIN, R. D.
    1969-1017, 1018; 1970-1012, 1072

MARTIN, R. P.
    1972-C076

MARTIN, W. E.
    1966-1047

MARTIN, W. P.
    1972-C001

MARTINEZ, A.
    1972-1164, 1165

MARVEL, J. A.
    1943-1001

MASCH, W. R.
    1972-1160

MASSIE, John Richard, Jr.
    1972-1103; 1973-1020

MATHERS, A. C.
1971-1164; 1973-1021

MAW, A. J. G.
1966-1046

MAXWELL, T. L., Jr.
1960-1001

MAY, D. M.
1966-1047

MAYBERRY, Keith S.
1971-1306

MAYES, H. F.
1972-C067

MAYROSE, V. B.
1971-1060

MAZURAK, A. P.
1972-C024

McALLISTER, J. S. V.
1970-1057

McANDREWS, C. J.
1966-1048

McCALLA, T. M.
1969-1050; 1971-1101, 1102, 1103, 1165, 1240; 1972-1052, 1104, 1105, C068, C069

McCAMPBELL, H. C.
1973-1009

McCARTY, P. L.
1967-1015

McCASKEY, T. A.
1971-1166; 1972-C003

McCLEAN, Garry R.
1972-1029

McCLURE, Kenneth E.
1971-1167, 1329; 1972-C051

McCLURE, W. H.
1965-1008; 1966-1029

McCORMICK, W. C.
1958-1003

McCOY, Elizabeth
1965-1022; 1966-1078; 1968-1044

McCROSS, John
1973-1022

McDANIEL, E. G.
1963-1003

McDONALD, R.
1968-1028

McEACHRON, L. W.
1969-1051

McELROY, A. D.
1972-1049

McFARLAND, J. M.
1972-1106

McGAUHEY, P. H.
1964-1012; 1968-1029; 1970-1029, 1030; 1972-1106

McGILL, H. N.
1971-1168

McGUFFEY, Kenneth
1972-1157

McILWAIN, R.
1971-1237

McINTIRE, Clifford G.
1970-1058

McKAY, K. A.
1968-1002, 1010

McKELL, C. M.
1965-1017

McKIEL, C. G.
1972-C031

McKINNEY, Ross E.
1965-1006; 1969-1052

McLAREN, G. A.
1968-1030

McNABB, Coy G.
1971-1215

McNABB, James F.
1972-1084

McQUITTY, J. B.
1972-1107

MEEK, A. M.
1969-1053

MEENAGHAN, George F.
1969-1087, 1088; 1970-1041, 1059, 1102; 1971-1007, 1057, 1258; 1972-1108

MEHREN, George L.
1966-1049

MEINHARDT, Paul
1971-1169

MELLER, Floyd H.
1969-1054

MELVIN, Stewart W.
1971-1170

MENDEL, V. E.
1966-1054

MENEAR, J. R.
1973-1023, 1033

MERRILL, W. G.
1969-1053

MESSER, James W.
1971-1171

METLIN, S. J.
1972-1048

MEYER, J. H.
1966-1035

MIDDEN,. T. M.
1971-1219

MIELKE, L. N.
1971-1240; 1972-1094

MILLER, Byron F.
1969-1056, 1057, 1058; 1970-1094, 1095, 1136; 1971-1172, 1173

MILLER, E. R.
1971-1194; 1972-C070

MILLER, Ed
1973-1017

MILLER, Ronald D.
1969-1004; 1970-1004; 1972-1007

MILLER, R. W.
1970-1063, 1064, 1065, 1066; 1971-1254

MILLER, William D.
1971-1174, 1175, 1176

MILLS, G. Alex
1971-1112, 1320

MILLS, John L.
1972-1016

MILNE, C. M.
1972-C071, C072

MINER, J. Ronald
1966-1050, 1051; 1967-1016; 1968-1031; 1969-1059, 1060; 1970-1046, 1067, 1068, 1115; 1971-1145, 1177, 1178, 1179, 1180, 1232, 1264; 1972-

1082, 1088, 1109, 1110, 1111, 1125, 1178, C073, C074

MINSHALL, Neal E.
1970-1069

MOBLEY, Earl D.
1970-1116

MOHSENIN, N. N.
1972-1087

MONKE, Edwin J.
1971-1107

MOODY, Wendell B.
1971-1181

MOORE, Earl N.
1954-1003

MOORE, James A.
1966-1034, 1969-1061, 1062; 1970-1071; 1971-1147; 1972-C075

MOORE, J. D.
1970-1070

MOORE, J. E.
1972-1067

MOORE, W. E. C.
1970-1026; 1971-1095

MORA, E. C.
1972-C003

MOREHART, A. L.
1972-C056

MORGAN, Neal O.
1969-1017, 1018; 1970-1012, 1065, 1066, 1072; 1971-1049; 1973-1024

MORRIS, W. H. M.
1966-1052; 1971-1182

MORRISON, C. S.
1966-1053

MORRISON, Joseph L.
1969-1063

MORRISON, S. M.
1971-1084; 1972-C076

MORRISON, S. R.
1966-1054; 1971-1183

MOUM, Stanley G.
1969-1076

MOUTNEY, G. J.
1969-1036, 1037; 1970-1067

MUEHLING, Arthur J.
1969-1064; 1970-1067, 1073; 1971-1184

MUIR, F. V.
1972-1071, 1112

MULKEY, Lee A.
1972-1113

MULLIGAN, Thomas J.
1972-1114

MULLINS, A. M.
1972-C039, C077

MURPHY, L. S.
1971-1163; 1972-1115

MURRAY, Clifton A.
1970-1074

MURTHY, G. K.
1971-1171

MUSGRAVE, R. B.
1969-1051

MYERS, Earl A.
1966-1055

NANSON, R. S.
1972-C078

NARAYAN, R. S.
1972-1017

NATH, K. R.
1972-1116

NATZ, Daryl
1972-1117

NEFF, M.
1971-1208

NELSON, Gordon L.
1969-1041

NELSON, W. E.
1972-C079

NESHEIM, M. C.
1972-1118

NGODDY, Patrick O.
1971-1185

NICHOLS, Merle S.
1966-1078; 1970-1069

NIELSEN, Darwin B.
1972-1119

NIENABER, J. A.
1972-1052

NIGHTINGALE, H. I.
1972-1120

NIX, Ronald
1962-1001

NODWELL, J. H.
1969-1081

NOLAND, Paul R.
1955-1001

NORSTEDT, R. A.
1971-1186, 1187, 1188

NORTHERN, W. L.
1973-1002

NORTON, T. E.
1969-1065

NURNBERGER, F. V.
1966-1056

NUTTING, Henry
1972-1211

NYE, John C.
1971-1189; 1972-C080

O'DELL, Richard A.
1969-1028

OGILVIE, John R.
1969-1023; 1971-1190

OKEY, Robert W.
1969-1066; 1971-1191

OLDS, Jerome
1960-1004

OLSEN, R. J.
1970-1034

OLSEN, S. R.
1972-C102

OLSON, A. E.
1971-1283

OLSON, P Parry
1972-1119

OMOHUNDRO, R. E.
1966-1057

ORCHARD, E. R.
1948-1005

ORR, D. E.
1971-1193, 1194

ORTUGLIO, C.
1970-1082

OSTRANDER, Charles E.
1965-1018; 1966-1058; 1967-1017; 1969-1067; 1971-1195, 1196, 1197, 1198; 1972-1121

OSWALD, William J.
1962-1008; 1966-1023, 1031; 1968-1014; 1971-1199; 1972-1035, 1122

OUSTERHOUT, L. E.
1971-1200

OVERMAN, A. R.
1971-1201

OWENS, A. D.
1960-1001

OWENS, Thomas R.
1968-1018; 1969-1068; 1971-1151

OWINGS, W. J.
1964-1001; 1965-1001

PAINE, Myron D.
1971-1043, 1044; 1972-1021, 1175, C016

PALAFOX, A. L.
1951-1002; 1952-1003

PALMER, G. L.
1969-1050

PALMER, Lane M.
1964-1013; 1966-1059

PARK, William R.
1972-1123

PARKER, Harry W.
1973-1013, 1020, 1025

PARKER, John
1971-1202

PARKER, M. B.
1959-1007; 1964-1014; 1966-1060

PARSO, A. A.
1969-1057

PARSONS, J. L.
1969-1069

PARSONS, Robert A.
1970-1075; 1972-1124

PATEL, Jawahar, D.
1967-1018

PATNI, N. K.
1972-1076

PATRICK, Homer
1967-1019

PATRICK, Tom
1971-1203

PAULSON, W. H.
1970-1034

PEARSON, R. W.
1972-C045, C065

PEREZ-ALEMAN, S.
1971-1204

PERKINS, H. F.
1959-1007; 1964-1014

PERRY, C. A.
1968-1040, 1041

PERSON, H. L.
1972-1082, 1125

PETERSON, Mirzda L.
1971-1205

PETERSON, O. H.
1969-1063

PETTET, A. E. J.
1946-1003

PFEFFER, John T.
1970-1076, 1111; 1971-1062, 1135, 1206

PHILLIPS, W. A.
1973-1039

PIATT, Cheryl
1967-1016

PIERCE, R. A.
1969-1053

PINCHIN, James H.
1972-1029

PITTMAN, Dwight L.
1971-1207

PLATT, Bryan
1969-1092

POELMA, H. R.
1971-1104

POLIN, D.
1971-1208

POLKOWSKI, L. B.
1966-1078; 1968-1044; 1971-1019, 1020, 1110; 1972-1012

POMEROY, B. S.
1971-1071

PONTIN, R. A.
1968-1032

POPE, W. H.
1972-1018

PORTER, Gilbert H.
1970-1077, 1113

PORTER, H. C.
1971-1259

PORTER, Lucy B.
1973-1015

POS, Jack
1969-1083; 1970-1078; 1971-1026, 1027, 1209; 1973-1027

POULTON, B. R.
1964-1004; 1967-1004

POWELL, R. D.
1972-1221

POWERS, W. L.
1972-1115

PRAKASAM, T. B. S.
1973-1019

PRATT, George L.
1969-1069; 1970-1140; 1971-1299; 1972-C081, C082

PRATT, Parker F.
1971-1004, 1210; 1972-C018

PRATT, Theodore B.
1972-1126

PRESSER, Robert H.
1971-1200

PRESTON, R. L.
1971-1167

PRICE, Fred
1970-1075, 1079; 1972-1127

PROCTOR, Donald E.
1969-1008; 1971-1253

PROHOROFF, John
1970-1033

PRYOR, W. J.
1964-1015

PUFFELES, M.
1938-1001

PURCELL, Thomas C.
1968-1006; 1972-1132

PUTNAM, Paul A.
1971-1211

QUISENBERRY, J. H.
1966-1061; 1969-1070

RADEMACHER, John M.
1969-1071, 1072

RAY, Maurice L.
1955-1001; 1959-1008; 1964-1016, 1017

READ, R. B., Jr.
1971-1171

REDDELL, Donald L.
1971-1212, 1287; 1972-C083; 1973-1026

REED, Charles H.
1966-1062; 1968-1046; 1969-1073

REEDER, Norman
1964-1018

REESE, Richard G.
1970-1120

REICHERT, K. A.
1969-1081

REID, J. T.
1971-1041

RENFROE, J. C.
1973-1001

RESNIK, Anthony V.
1969-1072

RETZER, John L.
1959-1006

RHODES, R. A.
1972-C084

RICHARDSON, Len
1972-1128

RICHTER, Jay
1971-1214

RICKETTS, Ralph
1965-1012

RICKLES, Robert N.
1969-1066

RIDLEN, S. F.
1972-1072

RIEHL, L. A.
1959-1009; 1962-1009

RIEMANN, Udo
1972-1129

RILEY, Charles T.
1964-1019; 1966-1063; 1968-1033; 1969-1091, 1094; 1970-1080

RILEY, Gardner M.
1942-1003

ROBBINS, Jackie W. D.
1971-1215, 1216, 1217; 1972-1130

ROBERTSON, L. S.
1970-1081, 1085

ROBINSON, J. B.
1969-1025; 1971-1209; 1972-1013, 1036, 1038, 1131; 1973-1027

ROBINSON, K.
1971-1218

ROBSON, C. M.
1969-1010

RODRIGUEZ, J. L., Jr.
1959-1009; 1962-1009

ROGERS, Charles J.
1972-1132

ROHLF, John
1963-1010

ROLLINS, G. H.
1971-1166

ROMINE, N. K.
1963-1003

ROSENBERG, M. M.
1951-1002; 1952-1003

ROSS, I. J.
1971-1118, 1219, 1310;
1972-1133, C085

ROSS, O. B.
1943-1002

ROTH, A. R.
1961-1005

ROTHCHILD, Irving
1946-1005

ROUSE, R. D.
1966-1016

RUBIN, Max
1946-1002, 1004, 1005;
1947-1001, 1002, 1003;
1948-1002, 1004

RUSNAK, John J.
1966-1064

RUSSELL, John
1965-1019

RUSSELL, Walter
1965-1004

SALAZAR, E.
1951-1003

SALTER, P. J.
1963-1011; 1967-1020

SALVESON, R. E.
1972-1067

SANCHEZ, S. A.
1973-1028

SAN CLEMENTE, C. L.
1970-1042

SANDS, D.
1972-C007

SANNER, W. S.
1970-1082; 1972-1137,
1138

SATTER, Adbus
1964-1020

SATTERWHITE, Melvin B.
1972-1134

SAVERY, C. William
1972-1135

SAXON, J. R.
1971-1218

SAYLOR, W. W.
1972-1136

SCAIFE, M. A.
1971-1220

SCALF, Marion R.
1970-1083; 1971-1308;
1972-1084

SCARBROUGH, James H.
1972-1141

SCARPINO, Pasquale V.
1972-1132

SCHAFER, Mary L.
1971-1171

SCHAIBLE, Phillip J.
1961-1007, 1008

SCHAPLER, F. L.
1972-C038

SCHELTINGA, Henri M. J.
1966-1065, 1066; 1969-1074

SCHLESINGER, M. D.
1972-1137, 1138

SCHLEUSENER, Paul E.
1963-1008; 1971-1272

SCHLOUGH, D. A.
1972-1031

SCHMID, Lawrence A.
1969-1075; 1971-1163

SCHOENBURG, Robert B.
1967-1005

SCHOLZ, H. G.
1971-1221

SCHULTE, Dennis D.
1970-1053, 1111; 1971-1222; 1972-C060

SCHULZE, K. L.
1972-1194

SCHUMACHER, A. E.
1940-1002

SCHUSTER, Lee R.
1972-1139

SCHWIESOW, William F.
1971-1139, 1223

SCOTT, Milton L.
1971-1224; 1972-1140

SCOTT, T. W.
1972-1098, C086

SEELEY, Margaret S.
1970-1084

SEIER, L.
1972-1018

SELF, H. L.
1971-1284

SELTZER, William
1969-1076

SENIOR, Frank C.
1973-1029

SEWELL, John I.
1971-1225

SHAIBLE, P. J.
1971-1274

SHANNON, D. W. F.
1969-1077

SHAW, J. H.
1969-1058

SHELEF, Gedalyahu
1970-1124

SHEPPARD, C. C.
1970-1085; 1971-1085, 1226, 1238; 1972-1006, 1045, 1190, 1208

SHERROD, L. B.
1972-1080

SHINDALA, Adnan
1972-1141

SHIRLEY, R. L.
1966-1003; 1972-1067, 1151

SHUYLER, Lynn R.
1971-1290, 1308, 1972-1085; 1973-1030

SIDWICK, J. M.
1972-1142

SIMCO, J. S.
1972-C087

SINGH, Ram Bux
1972-1143, 1144

SINGH, Y. K.
1968-1034

SINISE, Jerry
1971-1227

SINKEVICH, Steven
1973-1031

SKAGGS, R. W.
1972-1070

SLINGER, S. J.
1949-1003

SLONEKER, James H.
1972-1183, 1215; 1973-1052

SMITH, Carroll N.
1960-1003

SMITH, Gary L.
1973-1025

SMITH, George R.
1968-1035

SMITH, Ivan C.
1973-1011

SMITH, Jay
1970-1123

SMITH, Lewis W.
1969-1078; 1970-1086; 1971-1114, 1228, 1229, 1230, 1231, 1251, 1254, 1313; 1972-1145, 1146; 1973-1023, 1032, 1033, 1034

SMITH, R. E.
1972-C088, C089

SMITH, R. J.
1971-1232; 1972-1082

SMITH, Wade M., Jr.
1967-1021

SOBEL, Albert T.
1966-1067, 1068; 1969-1079, 1080; 1970-1087; 1971-1159, 1160; 1972-1095, 1147, C090

SOMMERFELDT, Theron G.
1972-1148

SOONG, R.
1972-1018

SORG, Thomas J.
1970-1088

SOUTHERN, H. N.
1940-1003

SOUTHWELL, B. L.
1958-1003

SPILLER, Heinrich
1973-1053

SPINO, Donald F.
1972-1132

SPRAGUE, D. C.
1972-C027

SQUIBB, R. L.
1951-1003

SRINATH, E. G.
1973-1019

STAHL, George R.
1970-1089, 1113

STAINBACK, Sandra E.
1964-1007; 1971-1059; 1972-1024, 1025, 1026, 1027

STALEY, L. M.
1971-1233, 1267

STECKEL, J. E.
1972-C091

STEELE, J. H.
1966-1021

STEEN, Chester A.
1970-1090

STEFFGEN, Fred W.
1972-1150

STEPHENS, E. L.
1972-1151

STEPHENS, Edgar R.
1971-1234, 1235

STEPHENS, George R.
1971-1236, 1322; 1972-C092

STEPHENSON, E. L.
1970-1125

STEPPLER, H. A.
1967-1022

STERN, Eric W.
1965-1020

STEVENS, F.
1966-1011

STEWART, B. A.
1967-1023; 1970-1091; 1971-1164; 1972-C093; 1973-1007, 1021

STEWART, T. A.
1971-1237

STEWART, T. Bonner
1970-1020

STIVERS, R. K.
1958-1002

STOLTENBERG, David H.
1965-1006

STRACHAN, N. H.
1966-1024

STRAUB, Charles
1967-1024

STROSHINE, Richard L.
1971-1242, 1244

STROWIG, L. Dean
1971-1028

STUBBLEFIELD, Thomas M.
1966-1069

STUEDEMANN, J. A.
1971-1262

SURBROOK, T. C.
1970-1085, 1092; 1971-1238

SUTTON, A. L.
1972-C094

SWADER, F.
1972-C095

SWANSON, Norris P.
1971-1239, 1240; 1972-C069

SWEAZY, Robert M.
1972-1060, 1218; 1973-1044

SWEETEN, John M.
1972-1152, 1189; 1973-1035, 1042, 1047

TAIGANIDES, E. Paul
1963-1012; 1964-1021; 1965-1010; 1966-1070, 1071, 1072; 1967-1003, 1014, 1025; 1968-1036, 1037; 1971-1187, 1188, 1241, 1242, 1243, 1244, 1260; 1972-1103, 1153, 1154, C096; 1973-1036

TAKA, M. R. Y.
1968-1008

TAYLOR, Jack C.
1971-1245, 1246, 1251, 1293; 1972-1078, 1195

TAYLOR, R. E.
1972-C077

TAYLOR, Robert B.
1969-1066

TELLER, Chester J.
1970-1093

TEN HAVE, P.
1971-1247

TENPAS, G. H.
1972-1031

TEOTIA, J. S.
1970-1094, 1095

THAYER, Donald W.
1971-1282

THOMAS, C. H.
1972-C097

THOMAS, G. W.
1966-1025

THOMAS, J. D.
1973-1021

THOMAS, J. W.
1970-1085, 1096, 1097; 1971-1040, 1248; 1972-1155, 1157, C098

THOMAS, Ralph
1964-1022

THOMPSON, John T.
1923-1001

THORNBERRY, Frederick D.
1972-1156

THYGESON, John R.
1971-1249, 1250

TIEDJE, J. M.
1972-1043

TIETJEN, Cord
1966-1073

TIETZ, Neil
1971-1251

TINNIMITT, Parnich
1972-1155, 1157

TITUS, H. W.
1946-1006

TOENJES, Don
1968-1038

TOLEMAN, William J.
1967-1031

TOPPS, J. H.
1971-1204

TORELL, D. T.
1966-1035

TOTH, S. J.
1965-1021

TOWER, Benjamin A.
1959-1002; 1961-1002; 1969-1016

TOWNSHEND, A. R.
1969-1081; 1970-1098

TRIBBLE, Leland F.
1973-1015

TUCKER, E. W.
1970-1099

TUCKER, R. E.
1970-1026; 1971-1095

TURK, Michael
1972-1199, C099

TURNBULL, J. E.
1971-1252

TURNER, C. W.
1947-1004

TURNER, Darrell O.
1971-1253; 1972-1214

TURNER, M. E.
1965-1011

TUTTLE, John
1971-1310

ULLREY, D. E.
1971-1194

UNDERWOOD, Clarence
1968-1039

UPDEGRAFF, D. M.
1972-C100

VANCE, R. D.
1971-1167

VAN DAM, J.
1968-1040, 1041

VANDERHOLM, Dale H.
1970-1100

VAN HOUWELING, C. D.
1971-1293; 1972-1191, 1210

VAN NOORLE JANSEN, Lucretia M.
1971-1143

VAN SLYKE, Steve
1973-1037

VAN VUREN, J. P. J.
1949-1001, 1004; 1972-1055

VARGHESE, S. K.
1971-1208; 1972-1159

VENNES, John W.
1970-1101, 1111

VERBEEK, W. A.
1960-1005

VETTER, Richard L.
1971-1289; 1972-1160, 1181, 1225

VICKERS, Albert F.
1969-1082

VIETS, F. G.
1967-1023

VIETS, F. G., Jr.
1971-1255; 1972-C101, C102

VOGEL, John
1972-1161

WADLEIGH, Cecil H.
1968-1042, 1048

WAGNER, D. G.
1972-C015

WAKEFIELD, R. C.
1972-C031

WALDROUP, P. W.
1966-1003; 1973-1038

WALKER, H. G., Jr.
1972-C103

WALKER, J. P.
1969-1083

WALKER, Kenneth C.
1967-1003

WALKER, M. L.
1964-1014

WALKER, W. S.
1971-1134

WALLINGFORD, G. W.
1972-1115

WALSH, L. M.
1971-1127

WALTERS, J. G.
1970-1082

WARD, John C.
1969-1084; 1972-C076

WARDEN, W. K.
1961-1007; 1971-1274

WARE, L. M.
1968-1043

WARNER, A. F.
1966-1013

WARREN, E. P.
1973-1009

WATERFALL, C. E.
1962-1010

WATKINS, Ralph
1971-1256

WEBB, K. E., Jr.
1970-1031; 1971-1095; 1972-1063, 1064; 1973-1006, 1012, 1039

WEBBER, L. R.
1968-1045; 1969-1022, 1029, 1085

WEBSTER, N. W.
1966-1074

WEEKS, M. E.
1972-1162

WEHBY, A. J.
1971-1171

WEHUNT, K. E.
1960-1006

WEIR, W. C.
1966-1035

WEISS, Alvin H.
1972-1163

WELLS, Dan M.
1968-1018, 1019; 1969-1031, 1032, 1068, 1086, 1087, 1088; 1970-1041, 1059, 1102; 1971-1007, 1057, 1257, 1258; 1972-1108

WELLS, Grant D.
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